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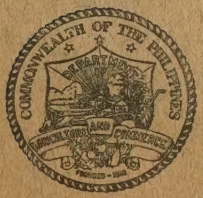

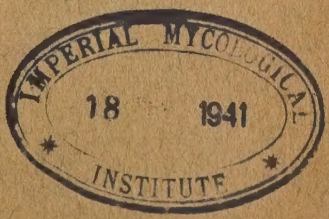

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A PRELIMINARY REPORT ON THE EFFECT OF DELAYED STRIPPING AND DRYING OF ABACÁ FIBER [1]

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TWO PLATES

A delay of several days in the stripping of abacá stalks, leaf sheaths and "tuxies" either by the "lucnet" or the "binacnes" method, and in the drying of the fiber in the Bicol region seems to be the probable cause of the production of poor grades of abacá fiber and apparently contributes much in the production of weak and damaged fiber, especially fiber of coarse cleaning. In the preparation of tuxies prior to hand stripping, the term "lucnet" is applied to a process of preparing 3 to 5 narrow ribbons from the outer layer of each leaf sheath as compared with the "binacnes" method in which only one wide tuxy is prepared from each leaf sheath, including the edges in both cases.

The object of this article is to present some results of experiments on delayed stripping and drying of abacá fibers upon the quality, tensile strength, and grades of fiber. In nearly all places hand stripping is still the prevailing method of fiber extraction and will be so for some time until the mechanized processes become in general use. For this reason the results of the preliminary trials reported in this paper are of much practical value to abacá producers.

[1] Received for publication August 26, 1940.

The work was conducted in the former Guinobatan Abacá Experiment Station, at Binogsakan, Guinobatan, Albay, for two years, 1929 to 1931.

MATERIALS AND METHODS

Delayed stripping of stalks.—Forty mature abacá stalks of *Puti-tomatagacan* variety were harvested and divided into four lots of ten stalks each and each lot was weighed separately. The first lot was prepared into "binacnes" and was stripped immediately under the Benito knife No. 40 (40 teeth per inch) with a constant tension of 64 pounds. The other lots were prepared one after another into "binacnes" and stripped at intervals of four days until the four lots had been worked out. After drying the fiber, ten samples of fiber from the middle portion of the sixth to the eleventh leaf sheaths from each lot were tested for tensile strength, separately. The dried fibers were weighed to determine the percentage of dry fiber and then graded by the Fiber Inspection Service at Legaspi, Albay. Each grade of fiber was separated and tied into hank and weighed separately. The test was conducted three times.

Delayed stripping of leaf sheaths.—Forty mature stalks of *Puti-tomatagacan* variety were harvested and divided into four lots of ten stalks, each lot weighing 88.4 kilos. Tuxies were prepared by the "binacnes" method from the leaf sheaths of the first group and were stripped immediately under the Benito knife No. 40, with a constant tension of 64 pounds. The fibers were immediately sun-dried to constant weight. All the leaf sheaths of the different groups were separated at the same time and, one after another, prepared into "binacnes" and stripped at intervals of every two days using the same knife No. 40 with the same tension of 64 pounds. The fiber was dried on the same day it was stripped. Afterwards the fiber from each lot was weighed and graded and the different grades were separated and tied into hanks and weighed separately on a pan balance. The tensile strength of the ten samples of fiber under each treatment was determined and the test repeated three times.

Delayed stripping of "binacnes".—Fifty mature abacá stalks of *Puti-tomatagacan* variety were harvested on the same day and were divided into five lots of ten stalks each, each lot weighing 88.4 kilos. The first lot was stripped immediately and the *binacnes* from other lots were placed on abacá leaves under the

TABLE 1.—*Effect of delayed stripping of stalks on the quantity, tensile strength, and quality of fiber produced. (Average of three tests)*

Treatment	Stalks used		Weight of dry fiber in kg.	Per cent fiber	Tensile strength in gms.	Grade in per cent of fiber by weight
	Number	Weight in kg.				
Stripped immediately	10	75	1.10	1.46	67,584	F-81.03, S2-18.97
4 days after	10	98	1.40	1.42	66,957	F-79.04, S2-13.76, S3- 7.20
8 days after	10	98	1.05	1.07	60,820	F-72.28, S2-18.18, S3- 9.54
12 days after	10	142	1.25	0.88	32,061	F-53.81, S2-11.43, S3-26.19, Y1-8.57

TABLE 2.—*Effect of delayed stripping of leaf sheaths on the quantity, tensile strength, and quality of fiber produced. (Average of three tests)*

Treatment	Stalks used		Weight of dry fiber in kg.	Per cent fiber	Tensile strength in gms.	Grade in per cent of fiber by weight
	Number	Weight in kg.				
Stripped immediately	10	88.4	1.309	1.47	67,882	F-78.80, S2-21.20
2 days after	10	88.4	1.230	1.39	61,250	F-48.54, S3-16.26, J1-35.20
4 days after	10	88.4	1.210	1.36	52,268	F-45.12, S3-18.51, I-22.48, G-13.89
6 days after	10	88.4	1.050	1.19	37,353	F-15.71, S3-23.62, G-15.14, H-45.53

TABLE 3.—*Effect of delayed stripping of "tuxies" (binacnes) on the quantity, tensile strength, and quality of fiber produced. (Average of three tests)*

Treatment	Stalks used		Weight of dry fiber in kg.	Per cent fiber	Tensile strength in gms.	Grades in per cent by weight
	Number	Weight in kg.				
Stripped immediately	10	88.4	1.279	1.45	66,896	F-82.44, S2-17.56
2 days after	10	88.4	1.234	1.38	57,172	F-81.29, S3-10.77, J1- 7.94
4 days after	10	88.4	1.057	1.18	49,920	F-35.76, S3-31.60, J1- 26.49, Y1-6.15
6 days after	10	88.4	0.967	1.07	47,625	S3-14.48, G-44.98, Y2-40.54
8 days after	10	88.4	0.921	1.04	32,583	S3-19.54, Y2-57.44, Y3-23.02

TABLE 4.—*Effect of delayed drying of abacá on the quantity, tensile strength, and quality of fiber produced. (Average of three tests)*

Treatment	Weight of		Per cent fiber	Tensile strength in gms.	Grades in per cent of fiber by weight
	Fresh fiber in kg.	Dry fiber in kg.			
Dried immediately	22	11.46	52.09	67.619	F-83.07, S2-16.93
12 hours after	22	11.11	50.50	60,125	F-63.29, S2- 9.81, I-20.20, J1-6.70
24 hours after	22	10.80	49.09	43,837	F-46.94, S3-7.59, I-41.38, G-4.09
36 hours after	22	10.40	47.27	50,818	F-43.25, S2-8.65, I-48.10
48 hours after	22	10.41	47.41	43,508	F-37.46, S2-9.70, I-45.45, S3-7.39

TABLE 5.—*Effect of drying abacá fiber under different conditions of sunlight.* (*Average of three tests*)

Treatment	Weight of		Per cent fiber	Tensile strength in gms.	Grades in per cent of fiber by weight
	Fresh fiber in kg.	Dry fiber in kg.			
Dried under direct sunlight	24.35	10.32	42.38	65,876	F-87.01, S2-12.99
In the shed	24.35	11.24	46.16	67.815	E-56.05, S2-12.90, F-31.05
Soaked in rain for 3 hours and then sun-dried	24.35	9.12	37.45	54.068	F-25.99, S2-17.76, I-56.25

shade on the ground. The "binacnes" from each lot were then stripped one after another at intervals of every two days under the same procedure described above. Ten fiber samples were separated and tested for tensile strength in the same way as above. The fibers from each lot were graded separately, each grade being separated and weighed. The test was conducted three times.

Delayed drying of fibers.—Five lots of 22 kilos each of fresh fiber stripped from mature abacá stalks of the variety *Putitomatagacan* under Benito knife No. 40 with a constant tension of 64 pounds were dried in the same condition one lot after another at intervals of every twelve hours. The first lot was dried immediately, the second, third, fourth and fifth lots were dried after 12, 24, 36 and 48 hours, respectively. While waiting for their turn to be dried, the different lots of fresh fibers were laid aside in bundles in the room. After drying to a more or less constant weight, ten samples from each lot of fibers were graded, separating the different grades from each lot, bundled into hanks and then weighed separately. The experiment was performed three times.

Effect of different conditions of drying abacá fiber.—Three lots of 24.35 kilos each of fiber from mature abacá stalks of *Putitomatagacan* variety stripped under Benito knife No. 40 with a constant tension of 64 pounds were treated differently. The first lot was dried directly under the sun, the second under the shed, and the third lot was allowed to remain in the rain for about three hours and then dried under the sun. After drying to more or less constant weight ten samples from each lot were secured and tested for tensile strength. Then the fibers were graded and the different grades were tied in hanks and weighed separately. The experiment was conducted three times.

RESULTS

The results of the experiments are presented in tables Nos. 1 to 5 inclusive. Table 1 gives the effect of delayed stripping of the cut stalks, average of three trials; table 2, the average results of three tests on delaying the stripping processes with all the leaf sheaths already separated at the start of the experiment; table 3, the average results of three trials on delayed stripping of tuxies (*binacnes*); table 4, the average results of three trials with delayed drying of abacá fiber; and table 5, the effect of drying abacá fiber under different conditions.

DISCUSSION OF RESULTS

In all these experiments the object was to determine their effect on the percentage, tensile strength and grade of the fiber produced. Due to the limited number of trials, the results obtained may not stand statistical analysis; hence only the arithmetical averages were considered in the hope that these results will throw some light on the solution of some standing practical problems confronting the abacá producers.

Delayed stripping of stalks.—The percentages of fiber produced from cut stalks stripped at different intervals were variable, those immediately stripped producing 1.46 per cent dry fiber. Cut stalks stripped after four days produced 1.42 per cent fiber; those stripped after eight days gave 1.07 per cent fiber, and those stripped twelve days after, produced only 0.88 per cent fiber. Beginning with four days delay, the number of leaf sheaths drying and rotting, starting from the outermost leaf sheaths, increases with the delay in stripping and the tips and butts of the fibers produced therefrom turn light to dark brown.

The tensile strength of the fiber also decreases with a delay in stripping. The stalks that were stripped immediately showed the highest tensile strength, 67.58 kilograms per gram-meter; those stripped 4 days after, gave an average tensile strength of 66.96 kilograms per gram-meter; and those delayed eight days showed 60.82 kilograms per gram-meter, whereas those stripped after twelve days exhibited only 32.061 kilograms per gram-meter, the lowest tensile strength.

The stalks stripped immediately not only exhibited the greatest tensile strength and highest percentage of fiber but also produced better grades of fiber; and the grade of fiber became poorer as the stripping of the stalks was delayed. Immediate stripping produced fibers of excellent cleaning, 81.03 per cent F (25 per cent over fair current) and 18.97 per cent S2 (Streaky two); stalks that were stripped after four days gave additional streaky grade of fiber, yielding 79.04 per cent F, 13.76 per cent S2 and 7.20 per cent S3; those delayed eight days produced 72.28 per cent F, 18.18 per cent S2, and 9.54 per cent fiber S3 whereas those delayed twelve days gave 53.81 per cent F, 11.43 per cent S2, 26.19 per cent S3 and 8.57 per cent Y1 or damaged fiber. Most of the outermost leaf sheaths of the last lot were dried and very weak and colored dark brown thus producing damaged or lowest grade of fiber.

Delayed stripping of leaf sheaths "Bacbac".—The preparation of leaf sheaths preparatory to the making of "binacnes" is being practiced in the abacá sections of Camalig, Daraga, Guinobatan and Jovellar (plate 1, figure 1). The immediate stripping of "tuxies" from the leaf sheaths (table 2) produced only two grades of excellent cleaning, 78.80 per cent F and 21.20 per cent S2. When delayed for two days it resulted in the production of another lower grade under good cleaning, giving 48.54 per cent F, 35.20 per cent J, and 16.26 per cent S3. Delaying further for four days still produced lower percentages and lower grades under good cleaning such as 45.12 per cent F, 22.48 per cent I, 13.89 per cent G and 18.51 per cent S3. Stripping six days after, other lower grades under good cleaning were produced, thus yielding 15.71 per cent F, 15.14 per cent G and 45.53 per cent H and 23.62 per cent S3. The tip and butt ends of the fibers from the last two lots were dark brown.

The tensile strength gradually decreased as the stripping of leaf sheaths was delayed and a marked decrease of from 67.88 to 52.27 kilograms per gram-meter or 23.01 per cent reduction was observed after 4 days. Stripping the stalks after six days yielded very weak fiber with a tensile strength of 37.35 kilograms per gram-meter.

Stripping immediately gave 1.47 per cent fiber; stripping two, four and six days later gave 1.39, 1.36 and 1.19 per cent respectively. Some of the leaf sheaths had deteriorated after six days.

Delayed stripping of "binacnes".—The "binacnes" stripped immediately produced grades of excellent cleaning, 82.44 per cent F and 17.56 per cent S2 (table 3). A delay of two days produced two grades under excellent cleaning, 81.29 per cent F and 10.77 per cent S3 and one grade under good cleaning, 7.94 per cent J1; four days, some damaged fiber, thus producing 35.76 per cent F, 31.6 per cent S3, 26.49 per cent J1 and 6.15 per cent Y1; six days, 14.48 per cent S3, 44.98 per cent G and 40.54 per cent Y2; 8 days, damaged fiber with the exception of the outermost and part of the outer leaf sheaths that gave the lowest grade of excellent cleaning, 19.54 per cent S3. The inner and innermost leaf sheaths produced damaged fiber, 57.44 per cent Y2 and 23.02 per cent Y3.

As regards tensile strength, immediate stripping recorded 66.90 kilograms per gram-meter gradually decreasing as the

stripping was delayed showing 57.17, 49.92, 47.62 and 32.58 kilograms per gram-meter for every delay of 2, 4, 6, and 8 days, respectively. With the last lot in which the tensile strength was 32.58 kilograms per gram-meter the decrease was 34.31 kilograms per gram-meter or about 50 per cent reduction which may be attributed to the damaged condition of the fiber after a delay in stripping of 8 days.

The percentage of fiber produced from immediate stripping of tuxies was found to be 1.45 per cent; when delayed for 2, 4, 6, and 8 days the percentages of fiber were 1.38, 1.18, 1.07 and 1.04, respectively. Apparently delaying the stripping of tuxies for four to eight days resulted not only in the decrease of tensile strength but also in the decrease of extracted fibers and in the lowering of the grades of the fiber produced.

Delayed drying of abacá fiber.—The drying of fiber (plate 2, figure 1) is an important problem in the Bicol region, especially as regards the question of fair to coarse cleaning. Oftentimes drying is delayed several days before the fiber is exposed to sunshine to dry.

Results in table 4 show that fresh fiber dried immediately after stripping produced 83.07 per cent F and 16.93 per cent S2 whereas the fiber that was dried after twelve hours gave lower grades of F, S2, I, and J1 in the proportion of 63.29, 9.81, 20.20, and 6.70 per cent, respectively, though they were all stripped at the same time under the same knife and tension. It is believed that the production of lower grades was due to the unfavorable action of tannic acid which was brought about when drying was delayed. After a delay of 24 hours or so still lower grades of fiber were obtained as can be seen in table 4.

The tensile strength of the fiber decreased from 67.62 kilograms to 43.84 kilograms per gram-meter after twenty four hours' delay in drying. Apparently, the drying of fiber should not be delayed for more than 12 hours so as to get the best quality fiber as regards tensile strength.

The quantity of fiber produced did not show marked differences between the different lots; nevertheless, after 36 hours' delay the percentage of dry fiber was reduced from 52.09 to 47.27 per cent.

Effect of different conditions of drying.—Abacá dried under the shed (table 5) gave the highest percentage (46.16) of dry fiber; that dried under direct sunshine gave 42.38 per cent dry fiber and the third lot which was kept in the rain for about

3 hours and then dried in the sunshine gave only 37.45 per cent fiber. The fiber placed under direct sunshine dried more thoroughly than that dried under shade, but the lot that was wet by the dripping rain lost some of its soluble components and upon drying thoroughly under the sunshine its weight was much reduced.

The highest grades of fiber were obtained from the shed-dried fiber, the E, F and S2 grades being produced in the proportion of 56.05, 31.05 and 12.90 per cent fiber respectively. The fiber dried under direct sunshine produced 87.01 per cent F and 19.99 per cent S2, whereas the third lot which was wet by rain and then dried in the sun gave 25.99 per cent F, 17.76 per cent S2 and 56.25 per cent I.

As regards tensile strength, the shed-dried fiber showed 66.815 kilograms per gram-meter; the sun-dried fiber gave 65.876 kilograms per gram-meter, and the other lot exhibited the lowest tensile strength of 45.078 kilograms per gram-meter. The results of this experiment apparently showed that fiber of excellent and good cleaning should be dried in the shed provided with adequate ventilation. Direct rays of the sun tend to reduce the tensile strength of the fiber and the dripping rain tends to wash some of the soluble chemicals essential to the production of good quality fiber.

An abacá drying house is indeed essential to insure the production of fiber of good quality. In Tigaon, Camarines Sur, there are abacá drying houses (plate 2, figure 2) where the fiber is dried after stripping to protect it from rain and direct heat of the sun. Fiber dried in such drying shed is lustrous and brilliant.

SUMMARY

The results presented in the foregoing discussion, constituting in every case the average of only three trials, throw some light on various important problems relative to stripping and drying of abacá fiber in the Bicol and Visayan regions. Oftentimes the stalks are cut and then kept to be stripped several days after cutting. According to the data presented in table 1, the delay should not be longer than four days if it is desired not to alter the tensile strength, quantity, and grade of the fiber. The outer leaf sheaths begin to dry out and the extremities of the stalk begin to rot after eight days, resulting in the reduction of the tensile strength and the turning to dark brown of the tip and butt of the fiber.

The separation of leaf sheaths is often practiced in some places in Albay principally in the towns of Camalig, Daraga, Guinobatan, and Jovellar. According to the data in table 2, a delay of two days in stripping affects very much the grades of fiber produced, and stripping after four days greatly reduces the tensile strength of the fiber. Hence it is advisable to strip the leaf sheaths once separated within a day or two to insure good grades of fiber and high tensile strength.

The preparation of tuxies in the plantation has been practiced in many places so as to lessen the weights of the materials to be carried from the plantation to the stripping shed. Oftentimes the stripping of these tuxies has been delayed for several days resulting in the production of lower or mixed grades of fiber. The results of three trials in table 3 indicate that the tuxies so prepared should be stripped in a day and that the stripping should not be delayed for two days after the preparation of the tuxies.

As regards the drying of abacá fiber, the results in table 4 indicate that the fiber should be dried immediately or within 12 hours after stripping, otherwise the tendency is towards a lowering of the grades of the fiber produced. A delay of 24 hours after stripping lowered the quantity of grade F fiber from 83.07 per cent to 46.94 per cent and after 48 hours it was still lowered down to 37.46 per cent. Not only should the fiber be dried immediately but it should also be placed in a properly ventilated drying shed. With fiber of excellent cleaning it was found out that drying in the shed tends to improve the grade of the fiber produced, as shed drying adds or imparts some degree of luster and brilliancy to the white color of the fiber.

ACKNOWLEDGEMENT

Acknowledgement is due to Mr. Sotero Albano and the personnel of the Fiber Inspection Service at Legaspi, Albay who graded the fiber under study and to Mr. Domingo S. Baybay, acting superintendent of the defunct Guinobatan Abacá Experiment Station, Binogsakan, Guinobatan, Albay, for his help in carrying out these experiments.

ILLUSTRATIONS

PLATE 1

FIG. 1. A woman preparing "binacnes" from abacá leaf sheaths.
2. A stripper stripping "binacnes" into coarse grade fiber. Note the file of "binacnes" on his left.

PLATE 2

FIG. 1. Common method of drying abacá fiber in Albay. The fibers are sometimes wet with rain water. The fibers are allowed to stay on the lines until they are dry.
2. Abacá drying shed in Tigaon, Camarines Sur with perfectly air-dry fibers.

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2

PLATE 1.

1

2

PLATE 2.

EFFICIENCY OF DIFFERENT BENITO KNIVES FOR STRIPPING ABACÁ [1]

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TWO PLATES

The abacá fiber known as *Manila hemp* in the world of commerce is extracted from the leaf sheaths of the abacá plant, *Musa textilis* Née, by passing under a knife of different serrations pulled either by hand or by machine. In different abacá-producing provinces different qualities of abacá fiber are produced due principally to the different stripping knives employed. In 1932 it was estimated that about eighty per cent of the abacá output in Negros was damaged and in Leyte most of the fibers were stripy and pulpy due to the use of defective knives of uneven teething. [2]

The use of Benito knives, in the absence of better ones, for stripping abacá helps greatly in improving the qualities and grades of fiber produced. It is believed that the use of Benito knives in stripping will greatly reduce the present high cost of classification and incident difficulties in the grading of fiber as are met with by the personnel of the Fiber Inspection Service and exporters. It may also be mentioned in this connection that, because of the prevailing low prices of abacá at present, the possibility of the small farmers to acquire stripping machines is rather remote, and for a long time hand-stripping might be the prevailing method. The main object of this study therefore is to determine the efficiency of different Benito stripping knives with special reference to the grades, quantity, and value of fiber produced.

The test was conducted at the Guinobatan Abacá Experiment Station, Binogsakan, Guinobatan, Albay, during the period from March, 1929 to August, 1930 inclusive—a period of about one year and five months.

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[1] Received for publication December 16, 1940.

[2] Rivera, Jose Jr. Survey No. 3. Fiber Standardization Board. 1932, pp. 1–19.

MATERIALS AND METHODS

Six Benito abacá hand-stripping knives with 16, 24, 30, 40, 46, and 0 serrations or teeth to the inch were tested, using regular sized and mature (heart just out) abacá stalks of the Itom variety. The leaf sheaths from each stalk were separated one after another in succession and then grouped into four, namely: (1) four outermost leaf sheaths, (2) second set of four leaf sheaths, (3) third set of four inner leaf sheaths, and (4) the innermost leaf sheaths. Generally the regular sized and mature stalks of the Itom variety consisted of from 15 to 17 leaf sheaths. Tuxies in the form of *binacnes* were prepared almost evenly in thickness and 100 kilos of *binacnes* constituting the four different layers of leaf sheaths were weighed on a "Fairbanks" balance and stripped immediately, repeating the test four times with each kind of stripping knife. The different knives were set on the block of wood serving as *incus* with different forces applied as follows: No. 0 knife, 84 pounds; No. 46, 72 pounds; No. 40, 64 pounds; No. 30, 56 pounds; No. 24, 52 pounds; and No. 16, 48 pounds.

The fresh fibers immediately after stripping were dried separately under the sun, and then classified and graded by the personnel of the Fiber Inspection Service in Legaspi, Albay. The graded fibers were properly labelled, tied into hanks and weighed separately in a pan balance.

The relative quantity and value of fiber stripped with different knives by a stripper and a helper in one day working nine hours was determined. A sufficient amount of *binacnes* was supplied the stripper. Five trials with each knife were made by the skillful stripper, each trial for nine hours. The fresh fibers were dried immediately under the sun and later in the shed to constant weight as determined by weighing in a pan balance.

Tests were performed to find the relative amount of moisture that the fresh fiber holds and the length of time to dry the different fibers stripped under different knives. The fresh fiber was first weighed and then dried under direct sunlight and afterwards in the drying shed, to constant weight. The loss in weight represents the quantity of moisture in the fiber. The number of hours it took the fibers stripped with different knives to dry under direct sunlight to constant weight was recorded.

In this connection, it must be stated that the cutting of stalks, the preparation of *binacnes*, and the stripping were done early

in the morning so as to be in time for the ten o'clock morning sun. The fiber was weighed hourly. Those requiring further drying after 6 hours in the sunshine, 10 o'clock in the morning to 4 o'clock in the afternoon were placed in a drying shed to be reëxposed at 7 o'clock the following morning. This test was repeated three times.

RESULTS

Table 1 shows the distribution of different grades of fiber in relation to the different Benito knives used and to different layers of leaf sheaths in the pseudostem using a total of 100 kilograms of tuxies for every trial; table 2, the mean weights of fiber and the mean differences; table 3, a summary of table 1 on the quantity and grades of fiber with their respective values. Table 4 shows the means and their differences in value of fiber stripped from different knives; table 5, the results of 5 trials including the quantity and value of abacá fiber stripped by a regular stripper in one day for nine hours using different knives; table 6, the computed percentages of fiber as stripped with different knives together with the value of cleaned fiber from 100 kilograms of stalks; table 7, the relative percentages and quantity of moisture held by the fresh fiber just after stripping with different knives; and table 8, the rate of drying of the fiber stripped with different knives as shown in table 6.

DISCUSSION OF RESULTS

The results of the experiments presented in this paper are of much interest and indeed valuable to abacá producers and strippers particularly in the proper choice of the stripping knives that will produce the precise grades of fiber required in the market.

Grades of fiber from the different sections of the pseudostem of abacá.—Examination of the data in table 1, particularly the distribution of the different grades of fiber, will show that with knife No. O, i. e., without serration, the outermost layer of leaf sheaths produced *Streaky Two* (S2) grade of fiber, the second outer layer, *Midway* (E) grade fiber, but the inner and the innermost leaf sheaths gave excellent grade of *Good Current* (CD).

With knife No. 46 (46 teeth to the inch), the outermost leaf sheaths produced *Streaky Two* (S2) fiber as with knife No. O; the second outer leaf sheaths gave *Midway* (E) and partly (F) or 25 per cent better than the *Fair Current* (I); the third

TABLE 1.—*Distribution of different grades of fiber in relation to the different layers of leaf sheaths in the pseudostem of abacá, variety Itom, as produced with different stripping knives*

Knife number	Weight of		Outermost leaf sheath			2nd Outer leaf sheath			Inner leaf sheath			Innermost leaf sheath		
	Tuxies	Dry fiber	Grade	Weight	Per cent	Grade	Weight	Per cent	Grade	Weight	Per cent	Grade	Weight	Per cent
	Kilos	*Kilos*		*Kilos*			*Kilos*			*Kilos*			*Kilos*	
0	100	7.244	S2	1.603	22.13	E	2.214	30.56	CD	2.328	32.14	CD	1.099	15.17
	100	6.222	S2	1.058	17.00	E	2.481	39.88	CD	1.614	25.94	CD	1.069	17.18
	100	6.600	S2	0.956	14.49	E	2.246	34.03	CD	1.921	29.11	CD	1.477	22.37
	100	6.850	S2	1.200	17.52	E	2.945	42.99	CD	1.808	26.40	CD	0.897	13.09
46	100	6.770	S2	1.569	23.17	E	2.013	29.14	E	2.068	30.51	CD	1.122	16.58
	100	8.700	S2	1.422	16.34	E	3.294	37.86	E	2.066	23.75	E	1.918	22.05
	100	8.190	S2	1.288	15.72	E	2.324	28.38	E	2.905	35.47	CD	1.673	20.43
	100	7.060	S2	1.161	16.44	F	2.945	41.72	E	1.921	27.21	E	1.032	14.62
40	100	8.060	S2	1.830	22.70	F	1.955	24.25	F	2.382	29.56	F	1.893	23.49
	100	8.780	S2	1.964	22.37	I	3.258	37.23	F	2.227	25.25	F	1.331	15.15
	100	9.010	S2	1.782	19.68	F	2.793	31.04	F	2.213	24.59	F	2.222	24.69
	100	8.030	S2	2.008	25.00	F	2.702	33.65	F	2.394	29.81	F	0.926	11.54
30	100	9.510	S3	2.020	21.24	J1	3.064	32.22	I	2.204	23.17	F	2.222	23.37
	100	9.600	S3	1.837	19.14	J1	3.420	35.62	I	3.348	34.88	F	0.995	10.36
	100	9.470	S3	1.677	17.79	J1	2.588	27.01	I	2.572	27.16	F	2.663	28.12
	100	9.150	S3	1.865	20.38	I	3.020	33.00	I	2.454	26.82	F	1.811	19.80
24	100	12.50	H	3.005	24.04	G	3.579	28.63	J1	2.733	21.86	J1	3.183	25.47
	100	10.90	H	2.769	25.40	J2	2.686	24.64	J1	2.837	26.03	J1	2.608	23.93
	100	10.30	H	2.165	21.02	G	2.940	28.54	J1	2.692	26.14	J1	2.503	24.42
	100	11.20	K	2.578	23.02	J2	3.143	28.06	J1	2.856	25.50	J1	2.623	23.42
16	100	13.30	M1	3.378	25.40	L2	3.205	24.10	L1	2.913	21.90	L1	3.804	28.60
	100	15.90	M2	4.218	26.52	L2	4.299	27.03	L1	3.912	24.61	L1	3.471	21.83
	100	13.00	M2	3.154	24.26	L2	2.817	21.67	L1	2.857	21.98	L1	4.172	32.09
	100	14.10	M2	3.576	25.36	L2	3.450	24.47	L1	3.219	22.83	L1	3.855	27.34

TABLE 2.—*The means and their differences in weights of fiber stripped from 4 trials of 100 kilos tuxies each with different knives*

Knives compared	Mean weight	Mean difference	Remarks
1. No. 16 vs. No. 24	14.20±0.448	3.00±0.53	Very significant
	11.20±0.310		Do.
2. No. 16 vs. No. 30	14.20±0.448	4.77±0.44	Do.
	9.43±0.066		Do.
3. No. 16 vs. No. 40	14.20±0.448	5.73±0.47	Do.
	8.70±0.168		
4. No. 16 vs. No. 46	14.20±0.488	6.52±0.62	Do.
	7.68±0.439		
5. No. 16 vs. No. 0	14.20±0.448	7.47±0.64	Do.
	6.72±0.458		
6. No. 24 vs.	11.20±0.310	1.77±0.31	Do.
7. No. 24 vs. No. 40	11.20±0.310	2.73±0.35	Do.
	8.70±0.168		
8. No. 24 vs. No. 46	11.20±0.310	3.52±0.53	Do.
	7.68±0.439		
9. No. 24 vs. No. 0	11.20±0.310	4.47±0.55	Do.
	6.72±0.458		
10. No. 30 vs. No. 40	9.43±0.066	0.96±0.18	Do.
	8.70±0.168		
11. No. 30 vs. No. 46	9.43±0.066	1.75±0.44	Slightly significant
	7.68±0.439		
12. No. 30 vs. No. 0	9.43±0.066	2.70±0.46	Significant
	6.72±0.458		
13. No. 40 vs. No. 46	8.70±0.168	0.79±0.47	Insignificant
	7.68±0.439		
14. No. 40 vs. No. 0	8.70±0.168	1.75±0.48	Slightly significant
	6.72±0.458		
15. No. 46 vs. No. 0	7.86±0.439	0.95±0.63	Insignificant
	6.72±0.458		

layer or inner leaf sheaths only the *Midway* (E) grade fiber; and the innermost leaf sheaths, the *Good Current* (CD) and *Midway* (E) grades in almost equal proportion.

The knife No. 40 (40 serrations per inch), as knife No. 46, stripped only *Streaky Two* (S2) from the outermost leaf sheaths. Grades (F) and *Fair Current* (I) were produced from the second outer leaf sheaths and only grade (F) fiber from the inner and innermost leaf sheaths.

With knife No. 30, the outermost leaf sheaths gave *Streaky Three* (S3) fiber; the second outer leaf sheaths, *Superior Seconds No. 1* (J1) and partly *Fair Current* (I); and the inner and innermost leaf sheaths, *Fair Current* (I) and (F), i. e., 25 per cent better than *Fair Current*, respectively.

The knife No. 24 stripped *Soft Brown* (H) and *Medium Seconds* (K) fiber from the outermost leaf sheaths; *Soft Second* (G) and *Superior Seconds No. 2* (J2) from the second outer leaf sheaths and *Superior Seconds No. 1* (J1) fiber from both the inner and innermost leaf sheaths. Knife No. 16, i. e.,

TABLE 3.—*Grades and value of fiber stripped from 100 kilos of tuxies with different knives*

Knife number	Grade of fiber	Weight of graded fiber	Percentage	Price per kilo [a]	Value of fiber
		Kilos		*Pesos*	*Pesos*
O	S2	1.204	17.89	0.10	0.12
	E	2.471	36.73	0.15	0.37
	CD	3.053	45.38	0.17	0.52
Total		6.728	100.00		1.01
46	S2	1.360	17.71	0.10	0.14
	F	0.736	9.58	0.13	0.10
	E	4.885	63.62	0.15	0.73
	CD	0.698	9.09	0.17	0.12
Total		7.679	100.00		1.09
40	S2	1.921	23.37	0.10	019
	I	0.814	9.91	0.10	0.08
	F	5.484	66.72	0.13	0.71
Total		8.219	100.00		0.98
30	J1	2.269	24.02	0.09	0.20
	S3	1.849	19.65	0.10	0.18
	I	3.377	35.89	0.10	0.34
	F	1.923	20.44	0.13	0.25
Total		9.409	100.00		0.97
24	K	0.644	5.74	0.06	0.04
	H	1.985	17.69	0.07	0.14
	J2	1.457	12.98	0.08	0.12
	G	1.629	14.51	0.08	0.13
	J1	5.508	49.08	0.09	0.50
Total		41.223	100.00		0.93
16	M2	2.737	19.45	0.06	0.17
	M1	0.844	6.00	0.06	0.05
	L2	7.050	50.09	0.05	0.35
	L2	3.443	24.46	0.05	0.17
Total		14.074	100.00		0.74

[a] Price per kilo of abacá fiber in Legaspi, Albay on February 10, 1940.

with 16 serrations to the inch, stripped *Medium Brown* (M1) and *Coarse Seconds* (L2) from the second outer leaf sheaths and *Coarse* (L1) from both the inner and innermost leaf sheaths.

Summarizing the foregoing results, several important facts may be briefly stated, namely, that using the same knife with a constant tension, the grades of fiber obtained gradually improved from the outermost to the innermost leaf sheaths. Grades of excellent cleaning were obtained from knives Nos. O, 46, and 40; fiber of good cleaning from knives Nos. 30 and 24, excepting the innermost leaf sheaths which gave fiber of excellent cleaning. Knife No. 30 stripped grades of excellent

TABLE 4.—*The means and their differences in value of fiber stripped with different knives*

Knives compared	Means	Differences	Remarks
No. 46 vs. No. 0	₱1.09±0.0162 1.01±0.0068	₱0.08±0.0968	Insignificant
No. 46 vs. No. 40	1.09±0.0162 0.98±0.0027	0.11±0.1161	Do.
No. 46 vs. No. 30	1.09±0.0162 0.97±0.0054	0.12±0.1034	Slightly significant
No. 46 vs. No. 24	1.09±0.0162 0.93±0.0027	0.16±0.1113	Do.
No. 46 vs. No. 16	1.09±0.0162 0.74±0.0299	0.35±0.0685	Significant

TABLE 5.—*Quantity and value of abacá fiber stripped with different knives by a regular stripper in one day of nine hours. (Average of five trials)*

Knife number	Average weight of fiber	Average price per kilo	Computed value of fiber	Share of—		
				Owner (½)	Stripper (¼)	Helper (¼)
	Kgms.	*Pesos*	*Pesos*	*Pesos*	*Pesos*	*Pesos*
0	14.76	0.140	2.07	1.03	0.52	0.52
46	18.60	0.137	2.55	1.27	0.64	0.64
40	20.10	0.110	2.21	1.10	0.56	0.56
30	24.30	0.102	2.48	1.24	0.62	0.62
24	31.00	0.076	2.36	1.18	0.59	0.59
16	42.28	0.055	2.33	1.16	0.58	0.58

TABLE 6.—*Quantity and value of fiber stripped from 100 kilograms of stalks with different knives. (Average of five trials)*

Knife number	Average quantity of stalks in kgms.	Quantity of fiber per 100 kgms. stalks	Average price per kgm.	Value of fiber from 100 kgms. stalk
		Kgms.	*Pesos*	*Pesos*
0	1,379	1.07	0.140	0.15
46	1,537	1.21	0.137	0.17
40	1,546	1.30	0.110	0.14
30	1,642	1.48	0.102	0.15
24	1,839	1.68	0.076	0.13
16	2,148	1.96	0.055	0.11

cleaning from the outermost and innermost leaf sheaths and grades of fair cleaning from the outer and inner leaf sheaths; knife No. 16, mostly grades of coarse cleaning.

It can be stated also that the separation of tuxies according to the origin of the leaf sheaths in the pseudostem of abacá into four groups, namely, 4-outermost leaf sheaths, 4-2nd outer leaf sheaths, 4-inner leaf sheaths and innermost leaf sheaths is not only practical but it also is advantageous in the classifi-

TABLE 7.—*Relative quantity of moisture held by the fresh fiber produced with different stripping knives*

Knife number	Weight of		Hours direct sunlight	Weight of dry fiber	Weight of moisture	Percentage	
	Tuxies	Fresh fiber				Moisture	Dry fiber
	Kgms.	*Kgms.*		*Kgms.*	*Kgms.*		
0	13.2	1.306	3	0.911	0.395	30.24	69.76
	12.5	1.000	2	0.722	0.278	27.80	72.20
	12.5	1.600	2	0.941	0,659	43.69	56.31
Average	12.7	1.302	2.3	0.858	0.444	33.91	66.09
46	13.2	1.605	3	0.960	0.645	40.02	59.98
	12.5	1.200	4	0.764	0.436	35.33	63.67
	12.5	1.700	4	0.985	0.715	42.04	57.96
Average	12.7	1.502	3.7	0.903	0.599	39.46	60.54
40	13.2	2.845	5	1.212	1.633	57.39	42.61
	12.5	2.560	6	0.962	1.598	62.42	37.58
	12.5	1.900	4	1.037	0.863	47.52	52.48
Average	12.7	2.435	5	1.070	1.365	55.78	44.22
30	13.2	2.970	23	1.231	1.739	58.55	51.45
	12.5	3.120	23	1.162	1.958	62.57	37.25
	12.5	2.700	22	1.212	1.488	55.11	44.89
Average	12.7	2.930	22.7	1.202	1.728	58.80	41.20
24	13.2	4.505	26	1.429	3.076	68.27	31.73
	12.5	3.520	26	1.225	2.295	65.19	34.81
	12.5	5.000	25	1.390	3.610	72.20	27.80
Average	12.7	4.342	25.7	1.348	2.994	68.55	51.45
16	13.2	8.620	27	1.772	6.848	79.40	20.60
	12.5	8.500	26	1.645	6.855	80.07	19.93
	12.5	7.960	27	1.720	6.240	78.38	21.62
Average	12.7	8.360	26.7	1.712	6.648	79.28	20.72

TABLE 8.—*Drying rate or evaporation ratio of the fiber stripped with different knives*

Knife number	Total drying hours	Hours direct sunlight	Total per cent moisture	Evaporation ratio	
				Total hours	Sunlight hours
				Per cent	*Per cent*
0	2.3	2.3	33.91	14.7	14.7
46	3.7	3.7	39.46	10.7	10.7
40	5.0	5.0	55.78	11.2	11.2
30	22.7	7.7	58.80	2.6	7.6
24	25.7	10.7	68.55	2.7	6.4
16	26.7	11.7	79.28	2.5	6.8

cation or grading of the fiber produced because each series of leaf sheaths produces definite grades of fiber and grouping the fiber according to origin will facilitate the classification. It must be noted in this connection that the usual practice in Albay particularly in Guinobatan, Jovellar, Camalig, Daraga, and

Albay is to separate the *binacnes* into three groups, namely, outermost leaf sheaths or *1st babá* and *2nd babá* or the next 4 to 5 inner leaf sheaths and the innermost leaf sheaths.

With the six different knives under study, one can select the proper knife or knives to use in producing the kinds or grades of fiber which are in demand in the market. For instance, for *Good Current* (CD) grade fiber, knife No. 0 should be employed; for *Midway* (E) grade, knife No. 46; for (F) grade, knife No. 40; for *Superior Seconds No. 1* (J1) grade, knife No. 24; and for *Coarse* (L1) grade, knife No. 16.

Quantity of fiber stripped with different knives.—A comparison of the total weight of fiber irrespective of grades is shown in table 2. A perusal of the data in this table will show at once that the mean differences are quite significant with the exception of cases Nos. 13 and 15 with insignificant differences of 0.79 ± 0.47 kilograms and 0.95 ± 0.63 kilograms of dry fiber, respectively. From these results it can be stated that the quantity of fiber produced is determined by the kind of knives used in stripping and that the less the number of serrations per inch of blade the greater is the amount of fiber produced. Knife No. 0 produced the least but the cleanest fiber and knife No. 16 gave the largest amount of fiber. Such conclusion is expected because the greater the number of serrations the cleaner is the fiber produced; in fact the knife No. 0, i. e., without serration, stripped fiber of excellent cleaning as stated above.

Value of fiber from 100 kilos tuxies as stripped with different knives.—The prices per kilo of abacá of different grades used in estimating the value of the fiber were obtained from the local market in Legaspi, Albay in February, 1940 (table 3). The knife No. 0 produced 6.73 kilograms of dry fiber of three grades, *CD, E,* and *S2,* in the proportion of 3.053, 2.471 and 1.204 kilos of fiber with corresponding values of ₱0.52, ₱0.37 and ₱0.12 or a total of ₱1.01. The knife No. 46 stripped 7.679 kilograms of fiber consisting of 0.698 kilo *CD,* 4.888 kilos *E,* 0.736 kilo F and 1.360 kilos *S2* with a total value of ₱1.09, or ₱0.08 greater than the value of the fiber stripped with knife No. 0, although their differences in value were insignificant.

An examination of the other data in the same table will show that knife No. 40 gave ₱0.98; knife No. 30, ₱0.97; knife No. 24, ₱0.93 and knife No. 16, ₱0.74. The knife which produced fiber of the highest value is knife No. 46 at the price given for different grades of fiber at Legaspi, Albay, in February, 1940.

Apparently, these results show that knife No. 46 not only stripped fiber of excellent cleaning, but also produced better fiber of higher total value from 100 kilograms of tuxies.

Comparing the relative values of the fiber stripped with knife No. 46 and other knives, it is clearly shown in table 4 that the differences in value of fiber stripped with knives No. 0, 40, 30, and 24 are insignificant, with differences of 0.08 ± 0.0968, 0.11 ± 0.1161, 0.12 ± 0.1034, and 0.16 ± 0.1113, respectively. Among the knives compared, knife No. 16 showed statistically a very significant difference of ₱0.35 ± 0.0685.

Quantity and value of fiber stripped by a regular laborer per day working 9 hours and using different knives.—The average weight of fiber stripped by a regular laborer in one day, working nine hours as shown in table 5, indicates that the finer the serration in the knife the less is the quantity of fiber produced but the value of daily production is highest with knife No. 46, giving 18.6 kilograms of fiber worth ₱2.55. The next is knife No. 30, stripping 24.30 kilograms of fiber valued at ₱2.48. The largest amount of fiber was produced with knife No. 16, giving 42.28 kilograms fiber of coarse cleaning but valued at ₱2.33. Basing on the value of the daily output, the use of knives Nos. 46 and 30 is more advantageous to both the owner and stripper than the other knives tested.

Quantity and value of fiber stripped from 100 kilograms of stalks as stripped with different knives.—In table 6, it can be seen that knife No. 0 stripped the least amount of stalks weighing 1,379 kilograms, and consequently the least amount of fiber weighing only 14.76 kilograms; knife No. 46 (with 46 serrations to the inch), 1,537 kilograms of stalks which gave 18.60 kilograms of fiber. As the quantity of stalks to be stripped with knives of less number of teeth to the inch is increased, the quantity of fiber produced is correspondingly increased, because knives with less number of teeth require less force and therefore the stripping is easier. With the coarser knife, therefore, the resulting fiber possess more pulp adhering to the fiber proper and because of this condition the grade together with the corresponding price per kilogram of fiber becomes lower. The value of fiber stripped from 100 kilograms of stalks was highest with knife No. 46 producing 1.21 kilograms fiber valued at ₱0.17, followed by knives Nos. 0 and 30, the production being 1.07 and 1.48 kilograms of fiber, both valued at ₱0.15 each. Again it can be stated that knife No. 46 is more economical to use not only from the

laborer's standpoint but also from the standpoint of fiber production per unit quantity of stalks considering the value of the produce.

Constant weight of fiber.—Constant weight of fiber in this report means the ordinary weight of a given quantity of dry abacá fiber in commerce supposedly free from any surplus moisture that oftentimes promotes rapid deterioration. An appreciable further reduction of its moisture content either by artificial or natural method would result in the reduction of its elasticity and lowering of the corresponding tensile strength, as excessive drying of abacá fiber tends to make it brittle.[3]

Drying period of fiber stripped with different knives.—The fiber stripped with knife No. 0 required 2.3 hours, under direct sunlight, to dry to constant weight; that with knife No. 46, 3.7 hours; and that with knife No. 40, 5 hours. The fiber stripped with knife No. 30 needed 22.7 hours, consisting of 7.7 hours in the sunshine and 15 hours in the drying shed and that stripped with knife No. 24 took 25.7 hours to dry to constant weight, this period consisting of 10.7 hours in direct sunshine and 15 hours in the drying shed. The fiber stripped with knife No. 16 required an average of 26.7 hours, i. e., 11.7 hours of sunshine and 15 hours in the shed.

It is understood that the period of drying abacá fiber to constant weight depends greatly upon the prevailing weather conditions at the time of stripping. During a cloudy day, not considering a rainy day, the fiber will of course require longer period to dry than when the day is clear. The above study was undertaken when the days were fairly clear with almost 8 to 9 hours (7 a. m. to 4 p. m.) of good sunshine. The light intensity of the sun at the time of the experiment was not determined as there was no available instrument for the purpose and, furthermore, it is believed that for practical purposes light intensity determination may not be very necessary.

From the foregoing figures on the number of hours for drying to constant weight, it can be inferred that with the use of knives Nos. 0, 46, and 40 the stripped fiber will require only a short time, not exceeding 5 hours of sunshine on a clear day, whereas, with knives Nos. 30, 24, and 16 the resulting fiber would require at least 22 hours; consequently molds and other dete-

[3] Unpublished results of experiment on oven drying showed significant weakening of the fiber. The paper is to be published later in this journal.

riorating fungi are likely to creep in, causing much damage to the fiber especially during cloudy and rainy days. Fiber of fair, coarse, and very coarse cleaning would need artificial drying in the event of rainy days so as to prevent deterioration.

Percentages of moisture.—The percentages of moisture varied inversely with the number of serration of the stripping knives used, that is, the less the number of serration per inch the greater is the amount of moisture present in the fiber and the more the serration, the less is the quantity of moisture present. The knife No. 0, i. e., without serration, produced fiber with 33.91 per cent moisture; knife No. 46, 39.46 per cent; knife No. 40, 55.78 per cent; knife No. 30, 58.80 per cent; knife No. 24, 68.55 per cent; and knife No. 16, 79.28 per cent. Evidently, the greater the amount of moisture in the fiber the longer it takes to dry to constant weight.

Drying rate or evaporation ratio.—The evaporation ratio or rate of drying in this report is determined by the following formula:

$$\text{Evaporation ratio} = \frac{\text{Per cent moisture}}{\text{Hours of drying}} = \text{Per cent per hour.}$$

The fiber stripped with knife No. 0 had an evaporation ratio or drying rate of 14.7 per cent per hour; knife No. 46, 10.7 per cent; and knife No. 40, 11.2 per cent. With knife No. 30, the stripped fiber showed an evaporation ratio of 7.6 per cent per sunlight hour or 2.6 per cent per hour including the drying period in the drying shed; with knife No. 24, 6.4 per cent per sunlight hour or 2.7 per cent per hour; and with knife No. 16, 6.8 per cent per sunlight hour or 2.5 per cent per hour. It is apparent that the coarser the fiber the slower is the rate of drying even considering only the total sunlight hours. This slow evaporation ratio or drying rate is due to the proportionate quantity of pulp adhering to the fiber proper, which naturally contains more moisture.

SUMMARY AND CONCLUSIONS

With the variety Itom, the efficiency of different Benito knives, Nos. 0, 46, 40, 30, 24, and 16, had been studied with special reference to the grade, quantity, and value of fiber produced.

With the same variety, the highest grade fiber *Good Current* (CD) was produced from the inner and innermost leaf sheaths, using knife No. 0, i. e., without serration. Generally, with the same knife and with a constant tension, better or higher

grades of fiber were produced as the stripping advanced from the outermost to the innermost leaf sheaths of the mature abacá stalks. Accordingly, the separation of tuxies before stripping into four groups, namely, (*a*) 4–outermost, (*b*) 4–outer, (*c*) 4–inner, and (*d*) innermost leaf sheaths is not only practical but it also facilitates the classification or grading of the fiber produced.

The results of this study indicate that it is possible to select the proper stripping knife or knives depending upon the grade of fiber in demand in the market, to wit: knife No. 0 for the production of *Good Current* (CD) grade fiber; knife No. 46 for *Midway* (E) grade; knife No. 40 for grade (F); knife No. 24 for grade (Jl) or *Superior Seconds No. 1*; and knife No. 16 for *Coarse* fiber or grade (Ll).

Of the six different knives tested, knife No. 46 with an applied force of about 72 pounds stripped fiber of the highest value. In one case it stripped from 100 kilograms of tuxies 7.679 kilograms fiber consisting of 63.62 per cent *E*, 17.71 per cent *S2*, 9.58 per cent *F* and 9.09 per cent *CD* with a total value of 1.09 ± 0.02 or ₱0.35 ± 0.07 higher than the value of the fiber stripped with knife No. 16, which was very significant. In another case, on the basis of daily output by a regular stripper, knife No. 46 gave 18.6 kilos of fiber worth ₱2.55, which was ₱0.07 higher than the second highest valued fiber stripped with knife No. 30, which was found to be 24.30 kilograms of lower grade fiber valued at ₱2.48. With 100–kilogram stalks as the basis, knife No. 46 turned out 1.21 kilograms of fiber worth ₱0.17 as compared with 1.07 and 1.48 kilograms of fiber, respectively, each valued at ₱0.15 produced by knives Nos. 0 and 30. These results indicate that knife No. 46 with 72-pound force applied is more economical to use than any other knives tested, not only from the laborer's and plantation owner's standpoint but also from the standpoint of fiber production per unit quantity of stalks or tuxies considering not the bulk but the value of the fiber produced.

The drying tests with abacá fiber showed that on a fairly clear day the fiber stripped with knives Nos. 0, 46, and 40 required only a short period, 2.3, 3.7 and 5.0 sunlight hours, respectively, but that stripped with knives Nos. 30, 24, and 16 needed much longer period.

The rate of drying is fastest in fiber stripped with knife No. 0 (without serration), being 14.6 per cent per sunlight hour;

the slowest rate, 6.4 per cent per sunlight hour, being observed in fiber stripped with knife No. 24.

It may be stated in passing that some varieties like the Tangoñgon, Maguindanao and Lawan in Mindanao were found to be rather tough and difficult to strip with hand-stripping devices thus needing the spindle stripping machine run by a 1½ to 3 H. P. motor. Those varieties found in Luzon and in the Visayas are in general soft enough to be hand-stripped with the Benito knives, the subject of this study.

ACKNOWLEDGMENT

Due credit is hereby given to Mr. Domingo S. Baybay, superintendent of the defunct Guinobatan Abacá Experiment Station, Guinobatan, Albay for the help he rendered in carrying out the experiments.

ILLUSTRATIONS

Plate 1

Benito knives having different number of serrations for stripping abacá fiber.

Plate 2

Fig. 1. Native hagotan in the Bicol region. An extraneous and slow process of fiber extraction.

Fig. 2. An abacá stripping machine run by motor power with an output of 2 piculs daily.

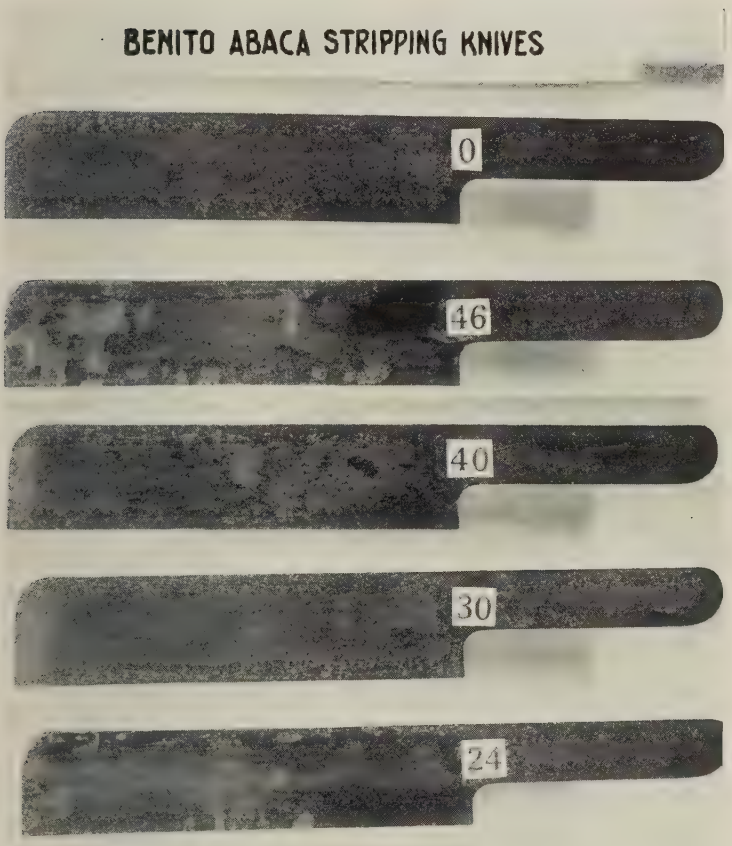

PLATE 1.

1

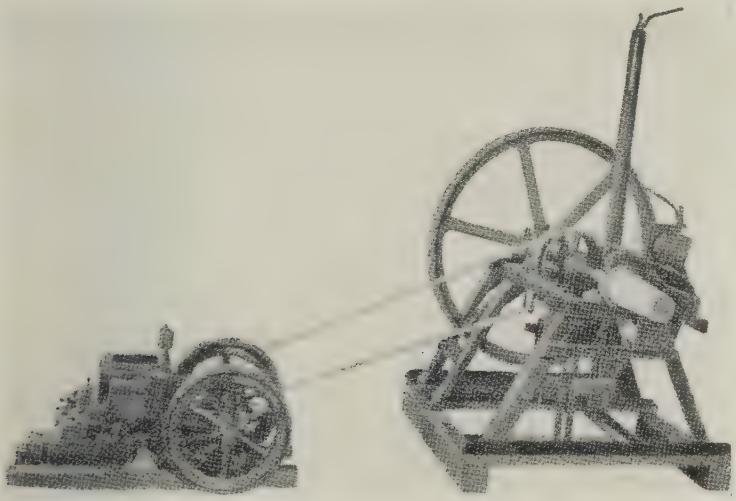

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PLATE 2.

DRY SHEATH-ROT OF ABACÁ CAUSED BY MARASMIUS AND SUGGESTIONS FOR ITS CONTROL [1]

By Mariano M. Ramos [2]

Of the Bureau of Plant Industry

THREE PLATES

In 1936, at the Abacá Disease Experiment Station, Silang, Cavite, Philippines, a gill-bearing fungus (*Marasmius*) was found attacking stunted abacá plants, locally known as "Tagil-til". The disease is sporadic in nature and generally appears after a long period of drought. The fungus attacks different varieties of abacá not only in Cavite, but also in Mindoro and in the Bicol region. The same disease is also found in Davao, Mindanao. The affected plants are stunted and gradually lose their healthy green color. Affected stems are discolored and brittle due to the effects of the fungus and are unfit for stripping. In most cases affected plants seldom recover and generally die prematurely.

Marasmius has been reported on abacá or Manila hemp (*Musa textilis* Née) (8) and (10), and several species of the fungus have also been recorded (16) in the Philippines to be associated with the decaying roots, woods and leaves of various plants. This gill fungus has been reported atacking cacao in Trinidad and Tabago (13) and oil palm in the Federated Malay States (17). A rot affecting the root and stem of sugarcane caused by an unidentified species of *Marasmius* has been reported by Hines (6) and Reinking (9) in the Philippines. Duggar (4) reported a root disease of sugarcane, the causal organism of which was identified by Wakker (18) as *Marasmius sacchari*. This trouble of sugarcane is said to have occurred in Hawaii and Louisiana (5) and West Indies (7). A root disease of banana identified as *Marasmius semiustus* has been reported by Stevens (14) from the West Indies, Trinidad, Hawaii and Mauritius. This fungus was also observed attacking the stem, peduncle and inflorescence

[1] Received for publication December 16, 1940.

[2] The writer is very grateful to Dr. Feliciano M. Clara and Mr. Julian A. Agati of the Plant Pathology Section for kindly reading and criticizing the manuscript.

of the banana plant. A similar type of disease has been observed(19) in the Philippines where it has been reported by Stevenson(15) as causing root and stem rot of banana. Deighton(2, 3) reported *Marasmius stenophylus* as attacking the pseudostem of Guinea negro variety as well as the Canary banana from Sierra Leone. Ashby(1) and Smith(12) reported the same fungus on "Bush" banana from Jamaica. Serrano(11) attributed the deterioration of some dark-colored abacá fiber to *Marasmius* infection of the outer leaf sheaths prior to stripping. This trouble of abacá is said to have occurred on the variety locally known as *abacang bayan* in San Antonio, Lonos, Laguna.

The data presented in this paper are the results of the studies on the fungus and its pathogenicity on abacá with suggestions on control measures.

NATURE OF THE DISEASE

The fungus first exists as a saprophyte in the soil, but later on it attacks the corms, eventually penetrating the other living tissues of the host plant. The organism is an aggressive parasite under high temperature and moisture conditions and once it gets access to the growing abacá plant, the vigorous and fast growing mycelium invades and destroys many of the roots and smothers the developing buds and suckers. On the stem, the affected portion turns dark brown and water-soaked in appearance. As infection progresses, the outer leaves dry up more rapidly than they are replaced by new growth. In most cases, the amount of foliage is greatly reduced and at times only two or three leaves remain. The affected plant is pale and stunted (plate 1, fig. 1.).

In the field, the fungous mycelium penetrates through the outermost leaf sheaths, tending to bind them together, thus causing them to dry up, impairing therefore the normal development of the plant. When the inner leaf sheaths are exposed, they show at various points irregular patches which are dark brown and water-soaked in appearance. These patches usually penetrate two or more leaf sheaths, gradually diminishing in size as they progress inward. White profuse mycelial growth usually develops at the point where the discolored patches extend from one leaf sheath to the other. Under favorable conditions, numerous fruiting bodies or sporophores develop on the seriously affected stems (plate 2). Generally premature death of the affected plants ensues.

MATERIALS AND METHODS

Isolation of the causal parasite.—The organism that causes the dry sheath-rot of abacá was readily isolated from the diseased abacá plants collected from the Abacá Disease Experiment Station at Silang, Cavite. Isolations were made from the roots and leaf sheaths of the diseased abacá plants. The materials were first rubbed with sterile cotton dipped in 1:1000 mercuric chloride solution and then rinsed with sterile water, so as to remove the mercuric chloride from the materials. With the aid of a flame-sterilized scalpel, the outer tissues were first removed and small sections were scraped off from the discolored inner tissues. The scalpel was sterilized every time a section was made. These sections were plated under aseptic conditions in Petri dishes containing 2 per cent hardened potato-dextrose agar. Two to three sections were plated in each Petri dish. After three to five days, white fungous growth appeared on the medium, from which transfers were made in test tubes containing also 2 per cent slant potato-dextrose agar.

Varieties used.—Different varieties of abacá were used for pathogenicity tests. The varieties inoculated were Tañgoñgon, Maguindanao, Baluñganon, Punukan, and Putian. The seedlings of each variety came from seeds or rootstocks obtained from healthy plants and grown in pots of sterilized soil in the greenhouse. The seedlings were inoculated at the age of from two to five months and only plants of the same age were used in every set of inoculation experiment.

Methods of inoculation.—Inoculations were made by inserting bits or weft of mycelium (5–10-day-old culture) in between the outermost leaf sheaths and by placing blocks of agar with the fungous mycelium on the base of the abacá plant just above the soil level. Blocks or bits of sterile water agar were placed in between the outermost leaf sheaths and on the base of the uninoculated or control plants instead of bits or weft of mycelium.

Inoculation experiments.—A series of inoculation experiments were conducted at different times of the year. The first set of inoculation was conducted on February 15, 1939, wherein seven potted healthy Tañgoñgon and seven potted healthy Maguindanao seedlings were used. The inoculated plants were placed in a moist chamber with a temperature of 28–33.5° C. for five days. On June 16, 1939, another six potted healthy Tañgoñgon and six potted healthy Maguindanao seedlings were

inoculated. The inoculated plants were placed in the moist chamber with a temperature of 27.5–32°C. also for five days. Another set of inoculation was made on October 6, 1939. Only four potted healthy Tañgoñgon and four potted healthy Maguindanao seedlings were used. The inoculated seedlings were placed in the moist chamber with a temperature of 25–31.5°C. for five days. A fourth series of inoculation was made on January 18, 1940, six potted healthy plants each (all from rootstocks) of the Tañgoñgon, Maguindanao, Baluñganon, Punukan, and Putian varieties being used. The plants were placed in the moist chamber with a temperature of 25–33.°5 C. for five days.

After the moist chamber treatment and during the observation period, the inoculated as well as the uninoculated or control plants were kept in a partially shaded place outside the greenhouse. The observations and results of the inoculation tests are shown in table 1.

TABLE 1.—*Results of the inoculation tests with the different varieties of abacá used*

Series of experiments	Varieties used	Number of plants used		Observations after		
				5 days[a]	4 months	6 months
I	Tañgoñgon	Inoculated	7	+	—	Two died, rest are stunted
		Control	3	—	—	Plants are healthy
	Maguindanao	Inoculated	7	+	2 died	One died, rest are stunted
		Control	3	—	—	Plants are healthy
II	Tañgoñgon	Inoculated	6	+	1 died	One died, rest are stunted
		Control	3	—	—	Plants are healthy
	Maguindanao	Inoculated	6	+	3 died	Plants are stunted
		Control	3	—	—	Healthy
III	Tañgoñgon	Inoculated	4	+	—	One died, rest are stunted
		Control	3	—	—	Plants are healthy
	Maguindanao	Inoculated	4	+	3 died	One died, rest are stunted
		Control	3	—	—	Plants are healthy
IV	Tañgoñgon	Inoculated	6	+	2 died	Plants are stunted
		Control	3	—	—	Plants are healthy
	Maguindanao	Inoculated	6	+	3 died	Two died, rest are stunted
		Control	3	—	—	Plants are healthy
	Baluñganon	Inoculated	6	+	3 died	Plants are stunted
		Control	3	—	—	Plants are healthy
	Punukan	Inoculated	6	+	—	Plants are stunted
		Control	3	—	—	Plants are healthy
	Putian	Inoculated	6	+	—	Two died, rest are stunted
		Control	3	—	—	Plants are healthy

[a] A plus (+) sign means that infection has been obtained; a minus (—) sign, no infection.

RESULTS AND OBSERVATIONS

It may be noted in table 1 that most of the inoculated plants were infected after five days. The first sign of infection is

the presence of irregular patches which are dark brown and water-soaked in appearance at the point of inoculation. As infection progresses, white mycelial growths appear on the dark brown lesions. The fungous mycelium makes more conspicuous progress upward, penetrating the inner leaf sheaths, thus binding them together. The affected leaf sheaths gradually dry up, followed by the yellowing of the leaves.

Observations showed that the different varieties of abacá inoculated show an irregular response to the disease. While a majority of the plants were infected after five days, some were readily attacked and others showed some sign of infection, but to a lesser degree. It was noted that the Maguindanao variety readily contracted the disease. Once the plant got infected, the outer leaf sheaths dried up more rapidly than they could be replaced by new growths and the amount of foliage was greatly reduced (plate 1, fig. 1). On the other hand, the Tangongon variety seemed to resist infection. It may be noted that the white mycelial growth on the stem tends to hold and bind the outermost leaf sheaths together, and as a result the leaves crowd at the top, indicating the unhealthy condition of the plant (plate 1, fig. 2).

Results showed that out of the 23 inoculated Maguindanao seedlings, 11 or 47.7 per cent died after three months; Balunganon, 3 out of 6 or 50 per cent; and Tangongon, 3 out of 23 or 13.1 per cent. More deaths were recorded after six months and practically all the varieties were found susceptible to the disease. The affected plants generally become stunted and gradually lose their healthy green color, but under conditions favorable for the development of the fungus the plants succumb to the disease more rapidly.

Field observations showed that the fungus spread in the plants by means of the vigorous and fast growing mycelium. Plants affected by the disease remained stunted for some time and then died prematurely. However, if the plants attain their fruiting stage, they are of no economic value for the attacked stalks are discolored and the fiber becomes weak, rendering them therefore unfit for stripping.

The growth and spread of the fungus are favored by improper cultural practices and prolonged warm moist weather conditions, and the occurrence of the disease is usually observed during humid days in poorly aërated and neglected plantations.

CULTURAL STUDIES

The abacá dry sheath-rot fungus was grown and observed on potato dextrose agar, corn meal, abacá corm plug and abacá stem plug.

Potato-dextrose agar.—Abundant and profuse white aërial mycelial growth was produced on the medium. With age, the mycelium turned grayish to brown and at times sporophores developed from the white mass of mycelium.

Steamed corn meal.—The growth of the fungus was profuse. The mycelium was grayish to white.

Abacá corm plug.—Abundant and profuse white fungous growth was produced on the medium. The mycelium turned grayish with age.

Abacá stem plug.—Abundant and profuse white to grayish fungous growth was produced on the medium. Unlike the other media, more fruiting bodies or sporophores developed on this medium. The sporophores persist for some time before they dry up or collapse.

DESCRIPTION OF THE FUNGUS

Sporophores or fruiting structures.—Under favorable temperature and moisture conditions, numerous fruiting bodies or sporophores develop on the affected stems (plate 2). The sporophores persist from 5 to 10 days and then gradually dry up or collapse due to lack of moisture. But as soon as moisture is applied, the sporophores are again revived.

Mycelium.—The mycelium (plate 3, fig. 1) is grayish to white, hyaline, very much branched which appears nonseptate when young but generally septate when mature.

Pileus.—The pileus (plate 3, fig. 2) is white, but turns dark with age. It is convex when young, flat or almost concave at maturity, with a diameter of 5 to 15 mm. Gills with an even thin edge and of straight radial direction are found on the lower side. The longer gills extend from the margin to a prominent ring on the stalk, while the shorter ones just fill in the angles between the longer gills.

Stipe.—The stipe is about equal in length to the diameter of the cap or pileus. It arises from the sides of the leaf sheaths. The stipe grows perpendicular to the leaf sheath, then it curves upward so as to bring the cap into a horizontal position. It is attached to the cap usually at its central point but occasion-

ally this attachment is somewhat eccentric. The stipe is white and smooth with a rather large and downy base.

Spores.—The spores are white, hyaline and ovate with a slight protuberance at the base. They range from 3.6 to 9.0 x 3.6 to 10.8 μ; and average almost 5.4 x 7.2 μ; and are borne by the sporophores (plate 3, fig. 2). Spores (plate 3, fig. 4) were found to germinate on dry glass slides after 24 hours.

The description of the fungus under study closely resembles that of *Marasmius semiustus* Berk. & Cust. Its occurrence on banana has been reported by Stevens(14) and Wardlaw(19). The Philippine fungus has its pileus measuring from 5 mm. to 15 mm. in diameter; spores ranging from 3.6 to 9.0 x 3.6 to 10.8 μ; and averaging almost 5.4 x 7.2 μ. According to Wardlaw(19), the pileus of *Marasmius semiustus* has a diameter of 5 mm. reaching 15 mm. in moist air; stalk or stipe, 7–9 mm.; and spores ranging from 5 to 6 x 7 to 8.5 μ or an average of 5.5 x 7.7 μ. The characteristic description of the Philippine *Marasmius* closely resembles that of *Marasmius semiustus* Berk. & Cust. to which it is referred.

CONTROL MEASURES

As the fungus is reported to occur on decayed woods, leaves and roots of various plants, sanitation in the plantation will greatly help reduce the spread of infection. Roguing of diseased plants as soon as detected in the fields would be beneficial in removing the primary source of infection. Proper distancing or setting of the plants should be well emphasized, as close planting is very conducive to the growth and rapid spread of the disease, especially in humid places. Since the fungus lives in the soil and spreads rapidly by means of the vegetative mycelium, it is advisable to get rootstocks from a disease-free field for planting purposes.

SUMMARY

1. A gill-bearing fungus causing root rot and dry sheath-rot of abacá or Manila hemp is hereby described. At present it is gaining a foothold in most of the neglected abacá fields in the Philippines.

2. The fungus primarily lives in the soil but penetrates the host through the corms and pseudostem. Diseased plants are pale and stunted. On and between the dead leaf sheaths, layers and patches of white mycelium may be observed. Numerous

fruiting bodies or sporophores develop on the affected stems as soon as favorable conditions occur.

3. Infection has been obtained by artificial inoculations with pure cultures of the fungus. The affected plants usually do not die immediately, but under favorable conditions they readily succumb to the disease. All the abacá varieties inoculated were susceptible to the disease.

4. The disease is caused by a fungus similar to, if not identical with, *Marasmius seminstus* Berk. & Cust., that causes stem and root rot of banana.

5. Being more or less a facultative saprophyte, strict sanitary measures will help greatly in checking the spread of the fungus. Roguing of diseased plants as soon as detected would reduce the primary sources of infection. Proper distancing and clean culture should be well emphasized as too close planting in humid places is conducive to the rapid growth and spread of the fungus. Rootstocks and suckers for planting purposes should be obtained from disease-free fields.

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ILLUSTRATIONS

(Photographed by the Bureau of Science)

PLATE 1

FIG. 1. An abacá plant (Maguindanao variety) artificially inoculated with *Marasmius* to show the partially rotted roots and pesudostem and the wilted leaves due to the fungus. The plant is pale and stunted as compared with the control (fig. 3).

2. An abacá plant (Tangongon variety) also inoculated with *Marasmius* to show the white mycelial growth fastening the dried leaf sheaths together. Note the crowding of the leaves as compared with those of the control (fig. 3).

3. A healthy Tangongon abacá plant of the same age as those of the inoculated at the left.

PLATE 2

Affected abacá stems to show the developing fruiting bodies or sporophores. Note the white gill-like structures (pileus) on the stems. (About natural size).

PLATE 3

FIG. 1. Pure cultures of the fungus in test tubes containing 2 per cent potato dextrose agar. Note the profuse white mycelial growth.

2. The fruiting bodies or sporophores. x1.

3. Spores in masses.

4. Germinating spores after 24 hours.

PLATE 1.

PLATE 2.

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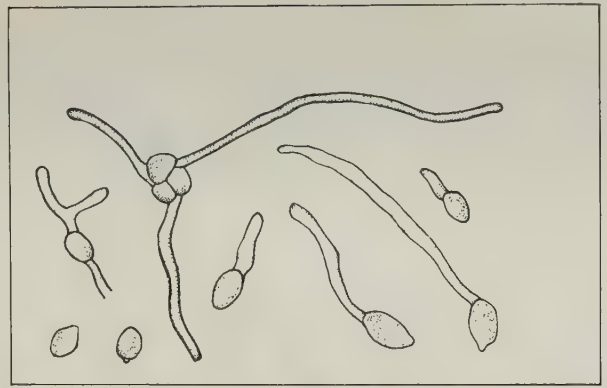

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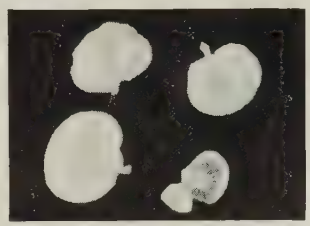

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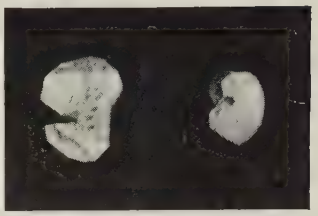

3

PLATE 3.

FURTHER VARIETY TEST OF CABBAGE [1]

By F. D. Lazo and Jose M. Ilagan [2]

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TWO TEXT FIGURES AND TWO PLATES

The increasing popularity of cabbage, *Brassica oleracea* var. *capitata* Hort. as a vegetable throughout the Philippines, demands more information about its wider culture in the lowland. Heretofore, cabbage growing in the lowland has often been met with varying degrees of disappointment, mainly because of the poor yields obtained from planting many a variety which is neither a good yielder nor adapted to the locality. One of the surest ways of increasing the yield of a unit area is to plant the highest yielding variety which is suited to the particular set of conditions obtaining in the locality.

In a variety test of cabbage conducted by Morada(2) in 1921, at the Lamao Horticultural Experiment Station, it was found that "varieties with conical heads are better producers of heads than those with round heads." However, it was reported that Late Flat Dutch and Solid South were the best yielders, and Late Flat Dutch and Surehead gave, on the average, the biggest heads. Rodrigo *et al.*(3) in their five-year test in four different stations, reported among other things, that "varieties found best yielders in one station were not necessarily the best in other stations." Of the more than 30 varieties tested, they reported Special Succession, Succession, Late Flat Dutch, Allhead Early, Charleston Wakefield, Surehead and Premium Flat Dutch as the best yielders.

The present study was undertaken to make a further test of the promising varieties reported by Rodrigo *et al.*(3) as already stated. New varieties, however, were included in the study. The cultures were undertaken in the Economic Garden, Los Baños, Laguna and in the Central Experiment Station, Manila during the vegetable seasons of 1937–1938 and 1938–1939.

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[1] This work is a continuation of that reported by Rodrigo *et al.*(3).

[2] Received for publication August 26, 1940.

MATERIALS AND METHODS

The cabbage varieties used in this study are listed in table 1, the variety names and the seedhouses from which they were ordered being given. The seeds were newly received when the cultures were started. With the exception of Early Flat Dutch, Louisiana Copenhagen and Wisconsin All Seasons, all the varieties used in this study were those found promising in the lowland by Rodrigo *et al.*(3).

The field.—The land used at the Los Baños Economic Garden has a very gentle slope toward the northeast side of the field, thus providing a good drainage and at the same time allowing for irrigation by the furrow system. The soil was brown clay loam, friable and deep, ranging from about 40 to 80 centimeters. The subsoil was tuffy clay and beneath it was disintegrating adobe. Several soybean crops had been raised prior to the planting of the two cabbage cultures. Judging from the stand of the previous crops, the field was fertile and quite uniform throughout.

The field was well prepared by plowing and harrowing several times. Unduly big clods were broken with the use of a roller. Particular attention was given to the elimination of weeds in the field so that their stubbles were thrown away during the course of each harrowing. The furrows which were made by passing a plow twice through the same line were 100 centimeters apart.

The garden plots in the Central Experiment Station had a light clay loam soil. The field preparations for both the 1937–1938 and 1938–1939 cultures were practically the same, the plot system being followed for both cultures.

The cultures at the Los Baños Economic Garden.—The seeds for the first culture were sown on November 16, 1937 in seed flats while those for the second culture were sown on October 28, 1938. The medium was ordinary garden soil obtained from places where weeds had been burned. Pricking was done on November 30, 1937 for the first culture and on November 18, 1938 for the second. The seedlings were properly dressed with ammonium sulphate dissolved in water, so as to obtain good and sturdy seedlings.

The seedlings were transplanted to the open field on January 6, 1938 for the first culture and on January 4, 1939 for the second. The layout of the planting may be seen in figures 1 and 2.

During the first few weeks after transplanting, the plants were watered with the use of a sprinkler. As they became bigger they were watered by furrow irrigation. This was done by making a shallow furrow between every two rows of plants through which water from faucets was made to flow. The experimental plots were constantly irrigated to keep the soil moist especially during the heading stage.

Cultivation was performed to loosen the soil and to kill the weeds as the situation required. Once the irrigation was accomplished through the furrow system, cultivation was considered unnecessary because the plants could take their needed moisture by seepage, and the surface soil did not harden as was the case when the irrigation was overhead. Moreover, the plants were already big enough to cover the spaces between them, thus suppressing the growth of the weeds.

A week after the seedlings were set in the open field, they were fertilized with a mixed fertilizer consisting of equal parts by weight of ammophos (20–20) and potassium sulphate (containing about 49 per cent K_2O). Each plant received about 20 grams of the mixture, applied in a small canal ring about 10 centimeters deep and 15 centimeters from the bases of the plants. They were again dressed with about 15 grams of ammonium sulphate per plant when their leaves were around 10 inches in diameter.

After transplanting, some of the young plants were attacked by crickets, *Gryllus testaceus* Walker [3], and a certain species of ground beetles. In some cases the plants were cut at the stem partially or wholly, thus killing the plants. Some aphids (*Aphis brassicae* Linn.) also caused trouble by sucking the tender parts of the young plants. The sucking insects were controlled with a soap solution spray. At about the maturing stage of the crop, a disease identified by the garden pathologist as black-rot (*Phytomonas campestris* [Pammel] Bergey) of cabbage attacked the plants. Disinfection at once with semesan, and proper disposal of the affected plants checked the rapid spread of the disease. Meanwhile, the irrigation water was withheld and the harvesting of matured heads accelerated.

Harvesting was begun as soon as the heads were mature. Indication of maturity was the hardiness of the heads upon being pressed with the hand and the presence of a solid sound upon being tapped with the fingers. The harvested heads were

[3] The specimen was kindly identified by the Department of Entomology, College of Agriculture, U. P.

then carefully weighed and the data recorded. The number of days required to mature the different varieties may be seen in tables 2 and 2a.

The culture at the Central Experiment Station.—The cultural treatments given to both the 1937–1938 and 1938–1939 tests were practically the same. The seeds were sown thinly in seedbeds previously prepared for the purpose on October 22, 1937 for the first season, and on October 21, 1938 for the second. The seeds having been sown directly in open seedbeds, pricking was not necessary. Instead, some of the seedlings were thinned out from the crowded spots. The seeds in the first culture had fair germination, but the young plants were poor because they were attacked by damping-off disease. In fact, the variety Improved Allhead Select was so seriously infected that it had to be eliminated from the second culture.

When the seedlings were about five inches high, they were transplanted at distances of 60 centimeters in rows 70 centimeters apart. In the 1937–1938 season the transplanting was delayed up to December 13, 1937 because of the typhoon on November 11, 1937 which set back the seedlings, while that of the 1938–1939 season was done on November 7, 1938.

It is to be noted here that the varieties Early Summer, Enkhuizen Glory, Charleston Wakefield, Wisconsin All Seasons and Succession in the 1938–1939 season had shown so poor a germination that the seedlings raised were not enough to cover the necessary replications.

At the time of planting, the plots were fertilized with ammophos (20–20) for the first culture and nitrophoska (16.5–16.5–20) for the second season. The fertilizer was applied uniformly in the holes made for the reception of the plants and then thoroughly mixed with the soil before planting. The rate of application was 500 kilograms per hectare. The plants were dressed three times with ammonium sulphate during each season at the rate of 100 kilograms per hectare per dressing.

Cabbage worms (*Crocidolomia binotalis* Zell.) and soft-rot (*Erwinia carotovora* (Jones) Holland) disease were the most common and destructive enemies of the plants. However, they were held in check by dusting, hand picking and spraying.

The first harvest was started on February 3, 1938 for the first season and on February 9, 1939 for the 1938–1939 culture. Recording of the harvest was by plots instead of by plants as was done with the Economic Garden harvest.

EXPERIMENTS AND RESULTS

The results of the two cultures conducted at the Los Baños Economic Garden and those at the Central Experiment Station during the vegetable seasons of 1937 to 1939 are presented in this paper.

In the first culture there were 13 varieties under trial, and in the second culture, 12 varieties. Tables 2 and 2a show the varieties, dates of sowing, pricking, transplanting and harvesting of the cultures at the Economic Garden. The records on the same phases of the work in the cultures at the Central Experiment Station appear in tables 2b and 2c. Tables 3 and 3a show the number and percentages of missing hills, diseased plants, headless plants, and heads harvested from the first and second cultures, respectively at the Economic Garden. The average weight per head and the coefficient of variability with the corresponding probable errors and the computed yield per hectare of each of the different varieties in the first culture are presented in table 4 and those of the second are shown in table 4a. Table 4b gives the results of the 1937–1938 culture and table 4c those of the 1938–1939 culture at the Central Experiment Station. Table 5 is a summary of tables 2 to 4a and it shows the average yield of the varieties in the two cultures at the Economic Garden; table 5a, the summarized results of the tests carried out at the Central Experiment Station, Manila.

DISCUSSION OF RESULTS

The data here presented are the results of two years' variety test on cabbage in two different experiment stations of the Bureau of Plant Industry.

ECONOMIC GARDEN CULTURE

The seeds used in both the first and second cultures did not have the same degree of viability although they were newly imported. In the first culture, the varieties Premium Flat Dutch, Succession, Early Flat Dutch, and Autumn King had poor germination, while in the second culture the varieties Louisiana Copenhagen, Wisconsin All Seasons, Improved Allhead Select, and Early Summer also showed poor germination. This accounted for the smaller number of plants used of the abovementioned varieties and it should be considered in the proper appraisal of the results herewith presented.

As already stated, the attack of some insect pests on the young plants was quite serious, particularly in the first culture where the seedlings were still quite young when transplanted. It was observed that some varieties seemed to be more susceptible than others. As seen in tables 3 and 3a, Copenhagen Market, Early Flat Dutch, Early Summer, and Charleston Wakefield had more missing hills than the rest while Wisconsin All Seasons had practically no missing hills. In the second culture where the transplanting was delayed and therefore the seedlings were old (68 days), the attack of cricket and ground beetle was negligible for obvious reasons.

In tables 3 and 3a are also presented data on the infection of some diseases on the different varieties tested. In the first culture, with the exception of Copenhagen Market, all the varieties were affected by black-rot of cabbage, the degree of infection varying from 2 to 10 per cent. Stonehead and Succession showed the highest degree of infection. In the second culture, a negligible disease identified by the pathologist of the Garden as foot-rot (*Phoma lingam* (Tode) Desm) of cabbage affected Charleston Wakefield, Improved Allhead Select, Premium Flat Dutch, and Enkhuizen Glory to the extent of from 1.4 to 2.9 per cent.

Heading.—As seen in tables 3 and 3a, the second culture had much better stand and heading percentage than the first. In the first culture the heading percentage ranged from 65.9 to 95 per cent, while in the second it varied from 80 to 100 per cent. In heading percentage, the five highest in the first culture were All Seasons, Early Summer, Enkhuizen Glory, Improved Allhead Select, and Premium Flat Dutch, their corresponding heading percentages being 95, 87.9, 86.9, 82.9, and 81.4. In the second culture the five best heading varieties were Wisconsin All Seasons, Surehead, Copenhagen Market, Enkhuizen Glory, and Succession with corresponding heading percentages of 100, 99, 98, 98, and 97. Premium Flat Dutch and Improved Allhead Select which were among the five highest in the first culture gave headings of 96 and 94 per cent, respectively.

Yield.—Like the heading percentage, the yield also varied in the two cultures. In the first culture, the average weight per head ranged from 356.51 ± 14.61 to 718.16 ± 22.89 grams (table 4) while in the second culture the weight ranged from 226.41 ± 10.25 to 1343.43 ± 37.03 grams. In the first culture the five varieties giving the heaviest average heads were Sure-

head, All Seasons, Early Stonehead, Improved Allhead Select and Enkhuizen Glory, and in the second culture, the five best were Premium Flat Dutch, Allhead Early, Surehead, Succession, and Improved Allhead Select. In the computed yield per hectare the five best in both cultures were those that gave the heaviest average weight per head. The total yield, however, was not only affected by the weight of the head but also by other factors like heading percentage and per cent stand of the crop at maturity. Based on these, the seven highest yielders in the first culture were All Seasons, Surehead, Improved Allhead Select, Enkhuizen Glory, Early Stonehead, Charleston Wakefield, and Allhead Early. The corresponding computed yields of these varieties were 17,137, 15,320, 14,375, 14,191, 13,196, 11,864, and 11,387 kilograms per hectare (table 4). In the second culture, the seven highest yielding varieties were Premium Flat Dutch, Allhead Early, Surehead, Succession, Improved Allhead Select, Wisconsin All Seasons, and Enkhuizen Glory, their corresponding computed yields per hectare being 34,707, 31,686, 31,293, 28,174, 23,991, 23,573, and 22,731 kilograms (table 4a). It will be noticed that Surehead, Allhead Early, Enkhuizen Glory, and Improved Allhead Select were among the seven best in both cultures. Summarizing the results of the two cultures, the seven best in the order of their average yields per hectare were Wisconsin All Seasons (23,573.7 kg.[a]), Surehead (22,924.5 kg.), Premium Flat Dutch (22,028.8 kg.), Allhead Early (21,536.9 kg.), Improved Allhead Select (18,758.7 kg.), Succession (18,383.8 kg.), and Enkhuizen Glory (18,323.0 kg.). It is interesting to note that four of the above varieties, namely, Premium Flat Dutch, Surehead, Succession, and Enkhuizen Glory were among the five best reported by Rodrigo *et al.*(3) under Los Baños conditions.

It will be noted in table 5 that the best varieties enumerated above were either medium or late maturing, requiring from 133 to 147 days from sowing to harvesting.

CENTRAL EXPERIMENT STATION CULTURE

Heading.—The heading percentages of the varieties tested varied from 57.7 to 100 in the first culture and from 38.5 to 90.7 in the second culture. The seven highest in the first culture were Charleston Wakefield, Autumn King, Early Flat Dutch, Enkhuizen Glory, Early Stonehead, Succession, and

[a] Average of one culture only.

Copenhagen Market (table 4b) ; in the second culture, Premium Flat Dutch, Allhead Early, Succession, Copenhagen Market, Wisconsin All Seasons, Golden Acre, and Charleston Wakefield (table 4 c).

Yield.—In the first culture the average yield for every 4-square-meter plot varied from 5.3 ± 0.15 to 8.98 ± 0.35 kilograms. The seven heaviest yielders were Charleston Wakefield, Autumn King, Enkhuizen Glory, Copenhagen Market, Early Summer, Succession, and Early Stonehead, their corresponding yields being 8.98 ± 0.35, 8.80 ± 0.29, 8.14 ± 0.51 8.07 ± 0.60, 6.67 ± 0.37, 6.32 ± 0.41, and 6.17 ± 0.67 kilograms (table 4b). In the second culture, the yield varied from 1.62 to 15.23 ± 0.33 kilograms for an 8-square-meter plot. Varieties Premium Flat Dutch, Allhead Early, Succession, Copenhagen Market, Wisconsin All Seasons, Golden Acre, and Charleston Wakefield were the heaviest yielders, their corresponding average yields for an 8-square-meter plot being 15.23 ± 0.33, 14.16 ± 1.31, 10.42[a], 8.94 ± 0.53, 7.62[a], 7.02 ± 1.00 and 6.46[a] kilograms.

Summarizing the results of the culture, the seven best at the Central Experiment Station, Manila, based on the computed average yields per hectare, were Autumn King (22,000 kg.[a]), Premium Flat Dutch (19,037.5 kg.[a]), Allhead Early (15,737 kg.), Copenhagen Market (15,650 kg.), Early Stonehead (15,425 kg.[a]), Charleston Wakefield (15,262 kg.), and Succession (14,402.5 kg.). It will be noted that Autumn King, Premium Flat Dutch, and Early Stonehead were tested for one season only, and their performance should be regarded in this light. In this connection, it may be stated that Enkhuizen Glory was third in yield in the first culture, but in the second its performance was very poor, due perhaps to poor viability of seed.

SUMMARY

This paper is a report on the results of two years' (1937 to 1938 and 1938 to 1939) work on cabbage variety test conducted at the Los Baños Economic Garden, Los Baños, Laguna and at

[a] Average of one culture only.

the Central Experiment Station, Manila. Sixteen varieties, most of which were found very promising in a previous study (3), were further tested in the present work.

At the Los Baños Economic Garden, the varieties Wisconsin All Seasons, Surehead, Premium Flat Dutch, Allhead Early, Improved Allhead Select, Succession, and Enkhuizen Glory were the seven best yielders based on two years' results. Their corresponding computed average yields were 23,573.7[a], 22,924.5, 22,028.8, 21,536.9 18,758.7, 18,383.8 and 18,323 kilograms per hectare (table 5).

At the Central Experiment Station, Manila, based on the two years' results, the heaviest producers were Autumn King[a], Premium Flat Dutch[a], Allhead Early, Copenhagen Market, Early Stonehead[a], Charleston Wakefield, and Succession, their corresponding computed average yields per hectare being 22,000, 19,037.5, 15,737, 15,650, 15,425, 15,262 and 14,402.5 kilograms.

While such varieties like Premium Flat Dutch, Allhead Early, and Succession were among the seven best in the Economic Garden and at the Central Experiment Station, the general trend of the results seems to indicate a preference of individual varieties for certain regions or localities as affected by climatic conditions and perhaps by the soil.

TABLE 1.—*List of cabbage varieties and their sources*

Varieties	Seedhouse or company	Country of origin
1. All Seasons	W. Atlee Burpee Co., Pa., Penn.	U. S. A.
2. Autumn King	Peter Henderson & Co., N. Y.	do.
3. Allhead Early	W. Atlee Burpee Co., Pa., Penn.	do.
4. Copenhagen Market	do	do.
5. Surehead	do	do.
6. Charleston Wakefield	Peter Henderson & Co., N.Y.	do.
7. Early Flat Dutch	W. Atlee Burpee Co., Pa., Penn.	do.
8. Early Stonehead	do	do.
9. Early Summer	Peter Henderson & Co., N. Y.	do.
10. Enkhuizen Glory	W. Atlee Burpee Co., Pa., Penn.	do.
11. Golden Acre	do	do.
12. Improved Allhead Select	do	do.
13. Louisiana Copenhagen	Steckler Seed Co., New Orleans, La.	do.
14. Premium Flat Dutch	W. Atlee Burpee Co., Pa., Penn.	do.
15. Succession	do	do.
16. Wisconsin All Seasons	do	do.

[a] Average of one culture only.

TABLE 2.—*Time of sowing, pricking, transplanting and number of days to harvesting of the 1937—1938 culture at the Los Baños Economic Garden, Los Baños, Laguna*

Varieties	Dates					
	Sown	Pricked	Transplanted	First harvest	Last harvest	Maturity of most of the crop
	1937	*1937*	*1938*	*1938*	*1938*	*1938*
1. All Seasons	Nov. 16	Nov. 30	Jan. 6	Mar. 11	Apr. 5	Mar. 22
2. Autumn King	Nov. 16	Nov. 30	Jan. 6	Mar. 9	Apr. 1	Mar. 22
3. Allhead Early	Nov. 16	Nov. 30	Jan. 6	Mar. 9	Apr. 5	Mar. 22
4. Copenhagen Market	Nov. 16	Nov. 30	Jan. 6	Mar. 9	Apr. 5	Mar. 9
5. Surehead	Nov. 16	Nov. 30	Jan. 6	Mar. 9	Apr. 5	Mar. 22
6. Charleston Wakefield	Nov. 16	Nov. 30	Jan. 6	Mar. 7	Apr. 5	Mar. 15
7. Early Flat Dutch	Nov. 16	Nov. 30	Jan. 6	Mar. 5	Mar. 22	Mar. 5
8. Early Stonehead	Nov. 16	Nov. 30	Jan. 6	Mar. 14	Mar. 31	Mar. 29
9. Early Summer	Nov. 16	Nov. 30	Jan. 6	Mar. 5	Apr. 1	Mar. 17
10. Enkhuizen Glory	Nov. 16	Nov. 30	Jan. 6	Mar. 7	Apr. 6	Mar. 22
11. Improved Allhead Select	Nov. 16	Nov. 30	Jan. 6	Mar. 15	Apr. 5	Mar. 29
12. Premium Flat Dutch	Nov. 16	Nov. 10	Jan. 6	Mar. 29	Apr. 22	Apr. 4
13. Succession	Nov. 16	Nov. 30	Jan. 6	Mar. 14	Mar. 29	Mar. 29

Varieties	Number of days from—		
	Sowing to transplanting	Transplanting to—	
		Harvesting	Maturity of the crop
1. All Seasons	51	64–89	75
2. Autumn King	51	62–85	75
3. Allhead Early	51	62–89	75
4. Copenhagen Market	51	62–89	62
5. Surehead	51	62–89	75
6. Charleston Wakefield	51	60–89	68
7. Early Flat Dutch	51	58–75	58
8. Early Stonehead	51	67–84	82
9. Early Summer	51	58–85	70
10. Enkhuizen Glory	51	60–90	75
11. Improved Allhead Select	51	68 89	82
12. Premium Flat Dutch	51	82 106	88
13. Succession	51	67 82	82

TABLE 2a.—*Dates of sowing, pricking, transplanting and number of days to harvesting of the 1938—1939 cabbage culture at the Los Baños Economic Garden, Los Baños, Laguna*

Varieties	Dates					
	Sown	Pricked	Transplanted	First harvest	Last harvest	Maturity of most of the crop
	1938	*1938*	*1939*	*1939*	*1939*	*1939*
1. Allhead Early	Oct. 28	Nov. 18	Jan. 4	Mar. 1	Apr. 5	Mar. 17
2. Copenhagen Market	Oct. 28	Nov. 18	Jan. 4	Feb. 14	Mar. 14	Mar. 11
3. Surehead	Oct. 28	Nov. 18	Jan. 4	Mar. 16	Apr. 5	Mar. 28
4. Charleston Wakefield	Oct. 28	Nov. 18	Jan. 4	Feb. 23	Mar. 30	Mar. 14
5. Early Summer	Oct. 28	Nov. 18	Jan. 4	Feb. 14	Apr. 5	Mar. 4
6. Enkhuizen Glory	Oct. 28	Nov. 18	Jan. 4	Feb. 18	Apr. 5	Mar. 8
7. Golden Acre	Oct. 28	Nov. 18	Jan. 4	Feb. 9	Mar. 14	Feb. 25
8. Improved Allhead Select	Oct. 28	Nov. 18	Jan. 4	Feb. 25	Apr. 5	Mar. 24
9. Louisiana Copenhagen	Oct. 28	Nov. 18	Jan. 4	Feb. 9	Mar. 16	Feb. 14
10. Premium Flat Dutch	Oct. 28	Nov. 18	Jan. 4	Mar. 21	Apr. 5	Apr. 1
11. Succession	Oct. 28	Nov. 18	Jan. 4	Feb. 21	Apr. 4	Mar. 11
12. Wisconsin All Seasons	Oct. 28	Nov. 18	Jan. 4	Feb. 27	Apr. 4	Mar. 21

Varieties	Number of days from—		
	Sowing to transplanting	Transplanting to —	
		Harvesting	Maturity of the crop
1. Allhead Early	68	56–91	72
2. Copenhagen Market	68	41–69	66
3. Surehead	68	71–91	83
4. Charleston Wakefield	68	50 85	69
5. Early Summer	68	41–91	59
6. Enkhuizen Glory	68	45–91	63
7. Golden Acre	68	36–69	52
8. Improved Allhead Select	68	52 91	79
9. Louisiana Copenhagen	68	36–71	41
10. Premium Flat Dutch	68	76–91	87
11. Succession	68	48–90	66
12. Wisconsin All Seasons	68	54–90	76

TABLE 2b.—*Dates of sowing, transplanting and harvesting and number of days to harvesting of the 1937—1938 cabbage culture at the Central Experiment Station, Manila*

Varieties	Dates				Number of days from—		
	Sown	Transplanted	First harvest	Last harvest	Sowing to transplanting	Transplanting to—	
						Harvesting	Maturity of the crop
	1937	*1937*	*1938*	*1938*			
1. All Seasons	Oct. 22	Dec. 12	Feb. 18	Mar. 11	63	68–89	114
2. Autumn King	Oct. 22	Dec. 12	Feb. 11	Mar. 5	63	61–83	135
3. Allhead Early	Oct. 22	Dec. 12	Feb. 17	Mar. 5	63	68–83	138
4. Copenhagen Market	Oct. 22	Dec. 12	Feb. 11	Mar. 1	63	61–79	133
5. Surehead	Oct. 22	Dec. 12	Feb. 11	Mar. 5	63	61–83	135
6. Charleston Wakefield	Oct. 22	Dec. 12	Feb. 11	Mar. 1	63	61–79	133
7. Early Flat Dutch	Oct. 22	Dec. 12	Feb. 3	Feb. 28	63	53–78	128
8. Early Stonehead	Oct. 22	Dec. 12	Feb. 11	Mar. 11	63	61–89	138
9. Early Summer	Oct. 22	Dec. 12	Feb. 11	Mar. 5	63	61–83	135
10. Enkhuizen Glory	Oct. 22	Dec. 12	Feb. 11	Mar. 5	63	61–83	135
11. Improved Allhead Select	Oct. 22	Dec. 12	Feb. 17	Mar. 11	63	67–89	141
12. Succession	Oct. 22	Dec. 12	Feb. 11	Mar. 5	63	61–83	135

TABLE 2c.—*Dates of sowing, transplanting and harvesting and number of days to harvesting of the 1938–1939 cabbage culture at the Central Experiment Station, Manila*

Varieties	Dates				Number of days from—		
	Sown	Transplanted	First harvest	Last harvest	Sowing to transplanting	Transplanting to—	
						Harvesting	Maturity of the crop
	1938	*1938*	*1939*	*1939*			
1. Allhead Early	Oct. 21	Nov. 17	Feb. 9	Mar. 8	28	85–112	126
2. Copenhagen Market	Oct. 21	Nov. 17	Mar. 16	Mar. 23	28	120–127	151
3. Surehead	Oct. 21	Nov. 17	Jan. 27	Mar. 4	28	72–108	118
4. Charleston Wakefield	Oct. 21	Nov. 17	Feb. 16	Mar. 16	28	92–120	134
5. Early Summer	Oct. 21	Nov. 17	Feb. 9	Mar. 8	28	85–112	126
6. Enkhuizen Glory	Oct. 21	Nov. 17	Feb. 16	Mar. 16	28	92–120	134
7. Golden Acre	Oct. 21	Nov. 17	Mar. 16	Mar. 23	28	120–127	151
8. Premium Flat Dutch	Oct. 21	Nov. 17	Feb. 24	Mar. 22	28	100–126	141
9. Succession	Oct. 21	Nov. 17	Feb. 16	Mar. 4	28	92–108	128
10. Wisconsin All Seasons	Oct. 21	Nov. 17	Feb. 16	Mar. 16	28	92–120	134

TABLE 3.—*Number and percentage of diseased, headless plants and heading of cabbage culture during the 1937-1938 crop at the Los Baños Economic Garden, Los Baños, Laguna*

Varieties	Number of—					Percentage of—		
	Plants set	Plants at harvest	Diseased plants	Headless plants	Heads harvested	Diseased plants	Headless plants	Heading
1. All Seasons	100	99	2	3	94	2.02	3.03	95.0
2. Autumn King	75	69	5	9	55	7.25	13.04	78.9
3. Allhead Early	100	94	-------	25	69	-------	26.60	73.4
4. Copenhagen Market	100	71	3	17	51	4.23	23.94	71.8
5. Surehead	100	95	2	17	76	2.11	17.89	80.0
6. Charleston Wakefield	100	83	5	9	69	6.02	10.84	78.4
7. Early Flat Dutch	75	59	4	7	48	6.78	11.86	81.4
8. Early Stonehead	100	96	10	15	71	10.42	15.63	74.0
9. Early Summer	100	83	2	11	73	2.41	13.25	87.9
10. Enkhuizen Glory	100	98	5	8	85	5.00	8.16	86.7
11. Improved Allhead Select	100	94	3	13	78	3.19	13.83	82.9
12. Premium Flat Dutch	25	24	2	3	19	8.33	12.50	79.0
13. Succession	50	47	5	11	31	10.46	23.40	65.9

TABLE 3a.—*Number and percentage of missing hills, diseased, headless plants and heading of the 1938—1939 cabbage culture at the Los Baños Economic Garden, Los Baños, Laguna*

Varieties	Number of—					Percentage of—			
	Plants set	Missing hills	Diseased plants	Headless plants	Heads harvested	Missing hills	Diseased plants	Headless plants	Heading plants
1. Allhead Early	72	------	------	4	68	------	------	5.56	94.44
2. Copenhagen Market	80	------	------	1	79	------	------	1.25	98.75
3. Surehead	101	------	------	1	100	------	------	0.99	99.01
4. Charleston Wakefield	102	------	3	4	95	------	2.94	3.92	93.14
5. Early Summer	40	------	------	3	37	------	------	7.50	92.50
6. Enkhuizen Glory	72	------	1	------	71	------	1.39	-------	98.61
7. Golden Acre	72	------	------	3	69	------	------	4.17	95.83
8. Improved Allhead Select	36	------	1	1	34	------	2.78	2.78	94.44
9. Louisiana Copenhagen	30	------	------	6	24	------	------	20.00	80.00
10. Premium Flat Dutch	96	------	2	1	93	------	2.08	1.04	96.88
11. Succession	114	------	------	3	111	------	------	2.63	97.37
12. Wisconsin All Seasons	36	------	------	-------	36	------	------	-------	100.00

TABLE 4.—*Weights per head, coefficients of variability and computed yields per hectare of the cabbage varieties during the 1937—1938 season at the Los Baños Economic Garden, Los Baños, Laguna*

Varieties	Average weights per head in grams	Coefficients of variability	Computed yields per hectare in kilograms [a]
1. Early Flat Dutch	356.51±14.61	42.04±3.36	7,738.7
2. Early Summer	419.46±16.18	48.85±3.30	9,932.3
3. Premium Flat Dutch	[b] 443.83±41.21	58.37±8.24	9,350.1
4. Autumn King	469.50±17.10	56.86±4.68	9,878.4
5. Succession	489.00±35.61	60.02±6.74	8,593.5
6. Copenhagen Market	493.66±21.99	47.16±3.78	9,452.1
7. Charleston Wakefield	567.50±21.32	46.24±3.15	11,864.7
8. Allhead Early	581.79±21.62	44.00±2.96	11,387.7
9. Enkhuizen Glory	613.83±19.63	42.92±2.65	14,191.9
10. Improved Allhead Select	650.26±25.95	52.23±3.50	14,375.4
11. Early Stonehead	668.72±21.19	39.55±2.55	13,196.2
12. All Seasons	680.41±21.36	45.09±2.62	17,137.3
13. Surehead	718.16±22.89	40.91±2.59	15,320.1

[a] Computed on the basis of 26,667 plants (50 x 75 centimeters) per hectare and the corresponding heading percentage of the different varieties as shown in table 3.
[b] N equals 19.

TABLE 4a.—*Average weights per head, coefficients of variability and computed yields per hectare of the cabbage varieties grown during the 1938—1939 season at the Los Baños Economic Garden, Los Baños, Laguna*

Varieties	Average weights per head in grams	Coefficients of variability	Computed yields per hectare in kilograms [a]
1. Louisiana Copenhagen	226.41±10.25	32.15±3.42	4,830.1
2. Golden Acre	359.55±13.80	47.23±3.25	9,188.3
3. Early Summer	622.15±37.57	54.19±5.41	15,346.6
4. Charleston Wakefield	747.27±19.54	37.96±2.09	18,560.4
5. Copenhagen Market	761.89±24.99	43.20±2.71	20,063.4
6. Enkhuizen Glory	864.45±23.24	33.57±2.09	22,731.9
7. Wisconsin All Seasons	884.00±33.26	33.47±2.99	23,573.6
8. Improved Allhead Select	[b] 952.65±46.64	42.31±3.74	23,991.8
9. Succession	1,085.05±24.84	35.75±1.81	28,174.0
10. Surehead	1,185.23±32.40	40.53±2.22	31,293.6
11. Allhead Early	1,258.17±37.48	35.86±2.36	31,686.1
12. Premium Flat Dutch	1,343.43±37.03	39.60±2.22	31,707.5

[a] Computed on the basis of 26,667 plants (50 x 75 centimeters) per hectare and the corresponding heading percentage of the different varieties as shown in table 3a.
[b] N equals 34.

TABLE 4b.—*Percentage of heading, average production per plot and the computed yields per hectare of the 1937–1938 culture at the Central Experiment Station, Manila*

Varieties	Percentage of heading	Area planted	Average production per plot	Computed yields per hectare
		Sq.m.	*Kilograms*	*Kilograms*
1. Charleston Wakefield	100.00	4.0	8.98±.3547	22,450.0
2. Autumn King	100.00	4.0	8.80±.2885	22,000.0
3. Enkhuizen Glory	88.27	4.0	8.14±.5068	20,350.0
4. Copenhagen Market	80.83	4.0	8.07±.6004	20,175.0
5. Early Summer	76.92	4.0	6.67±.3723	16,675.0
6. Succession	84.61	4.0	6.32±.4054	15,800.0
7. Early Stonehead	87.50	4.0	6.17±.6667	15,425.0
8. Early Flat Dutch	88.46	4.0	5.62±.4132	14,050.0
9. Allhead Early	65.38	4.0	5.51±.3527	13,775.0
10. Improved Allhead Select	77.41	4.0	5.50±.4873	13,750.0
11. All Seasons	57.69	4.0	5.34±.4990	13,350.0
12. Surehead	67.31	4.0	5.33±.1540	13,325.0

TABLE 4c.—*Percentage of heading, average production per plot and the computed yields per hectare of the 1938–1939 culture at the Central Experiment Station, Manila*

Varieties	Percentage of heading	Area planted	Average production per plot	Computed yields per hectare
		Sq. m,	*Kilograms*	*Kilograms*
1. Premium Flat Dutch	90.73	8.0	15.23±0.3301	19,037.5
2. Allhead Early	84.33	8.0	14.16±1.3059	17,700.0
3. Succession	85.18	8.0	10.42 [a]	13,025.0
4. Copenhagen Market	81.48	8.0	8.94±0.5309	11,175.0
5. Wisconsin All Seasons	59.25	8.0	7.62 [a]	9,525.0
6. Golden Acre	64.79	8.0	7.02±0.9997	8,775.0
7. Charleston Wakefield	55.55	8.0	6.46 [a]	8,075.0
8. Enkhuizen Glory	50.00	4.0	3.04 [a]	7,600.0
9. Surehead	49.99	8.0	5.72±0.0765	7,150.0
10. Early Summer	38.46	4.0	1.62 [a]	4,050.0

[a] Due to poor germination of the seeds, this was not replicated.

TABLE 5.—*Average number of days to harvesting and the computed yields per hectare of the different cabbage varieties tested*

Varieties	Average number of days from sowing to harvesting		Average computed yields per hectare	
	Economic Garden	Central Experiment Station	Economic Garden	Central Experiment Station
			Kilograms	*Kilograms*
1. Louisiana Copenhagen	[a] 109.0		[a] 4,830.1	
2. Early Flat Dutch	[a] 109.0	[a] 128.0	[a] 6,085.5	[a] 14,050.0
3. Golden Acre	[a] 120.0	[a] 115.0	[a] 9,118.3	[a] 8,775.0
4. Copenhagen Market	123.5	142.0	14,729.2	15,650.0
5. Early Summer	124.0	130.5	12,639.5	10,362.5
6. Autumn King	[a] 126.0	[a] 135.0	[a] 9,878.4	[a] 22,000.0
7. All Seasons	[a] 126.0	[a] 114.0	[a] 17,055.8	[a] 13,350.0
8. Charleston Wakefield	128.0	133.5	15,212.6	15,262.5
9. Enkhuizen Glory	128.5	134.5	18,323.0	13,975.0
10. Allhead Early	133.0	132.0	21,536.9	15,737.5
11. Early Stonehead	[a] 133.0	[a] 138.0	[a] 12,661.3	[a] 15,425.0
12. Succession	133.5	131.5	18,383.8	14,402.5
13. Surehead	138.5	121.5	22,924.5	10,237.5
14. Improved Allhead Select	140.0	[a] 141.0	18,758.7	[a] 13,750.0
15. Wisconsin All Seasons	[a] 140.0	[a] 134.0	[a] 23,573.7	[a] 9,525.0
16. Premium Flat Dutch	147.0	[a] 141.0	22,028.8	[a] 19,037.5

[a] Results of one trial only.

ACKNOWLEDGMENT

The writers wish to express their appreciation and thanks to Mr. Pedro A. Rodrigo of the Horticulture Section, Bureau of Plant Industry, who has contributed helpful suggestions during the progress of the work and in the presentation of the manuscript.

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ILLUSTRATIONS

PLATE 1

Twenty-seven-day-old cabbage plants at the Economic Garden during the 1937–1938 season. There were 13 varieties under trial.

PLATE 2

A general view of the 1938–1939 cabbage variety test culture at the Los Baños Economic Garden, Los Baños, Laguna. The heads are just forming.

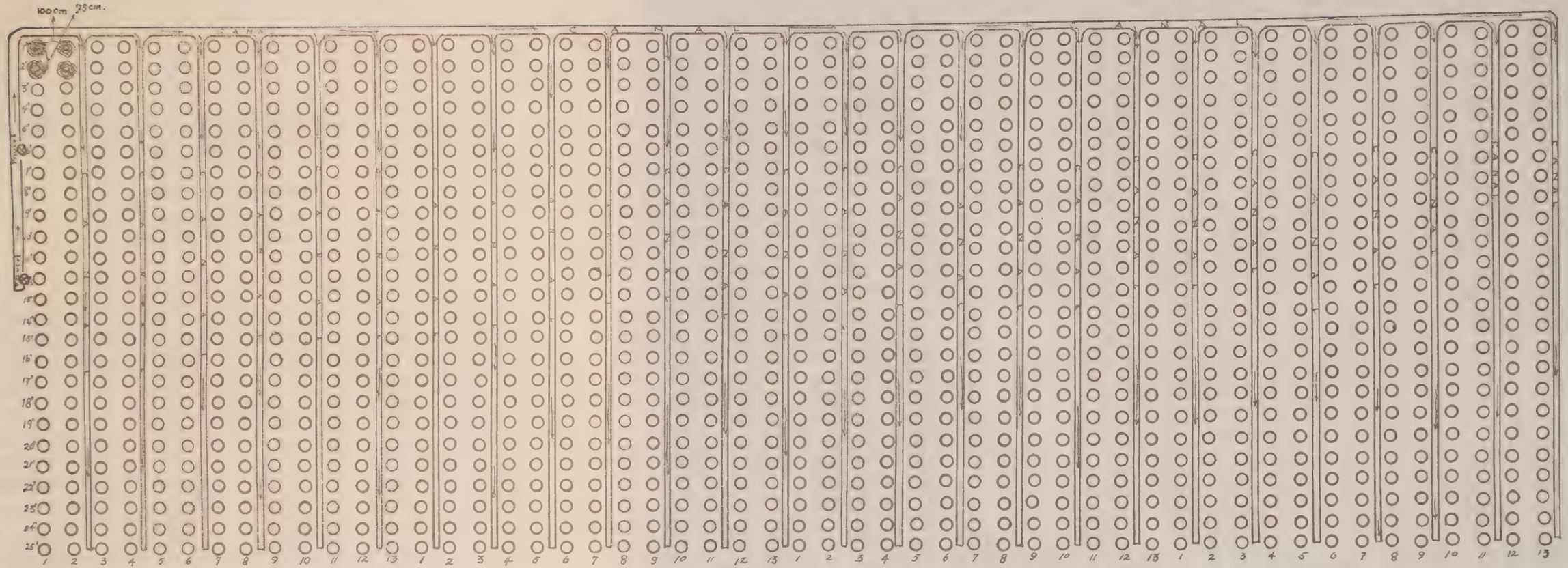
TEXT FIGURES

FIGS. 1. Layout of the cabbage culture during the 1937–1938 season at the Los Baños Economic Garden, Los Baños, Laguna: 1'–25' plant numbers in the row; 1, Early Stonehead; 2, Copenhagen Market; 3, Allhead Early; 4, Improved Allhead Select; 5, Charleston Wakefield; 6, Surehead; 7, Succession; 8, Early Summer; 9, Autumn King; 10, All Seasons; 11, Enkhuizen Glory; 12, Premium Flat Dutch; 13, Early Flat Dutch.

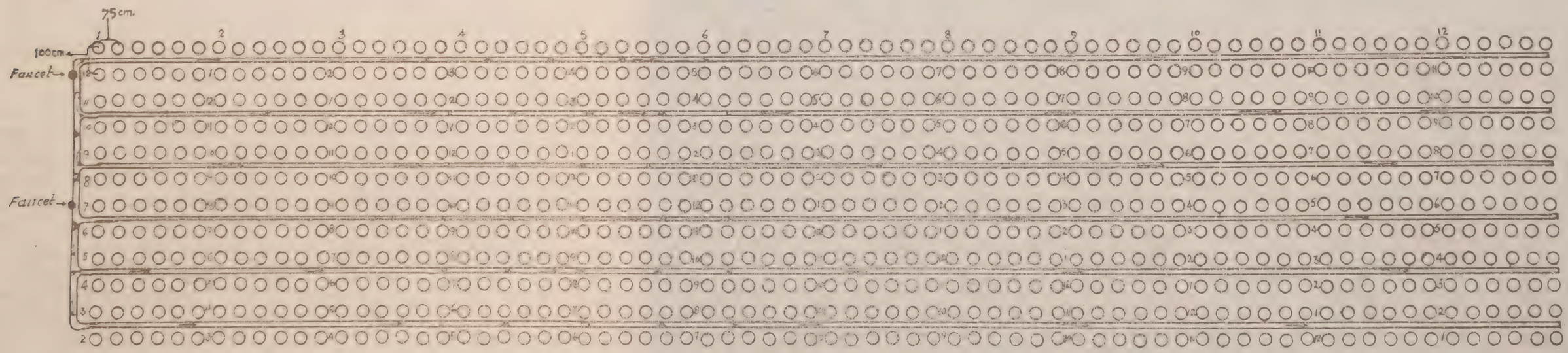
2. Layout of the cabbage culture during the 1938–1939 season at the Los Baños Economic Garden, Los Baños, Laguna: 1, Golden Acre; 2, Wisconsin All Seasons; 3, Early Summer; 4, Premium Flat Dutch; 5, Enkhuizen Glory; 6, Copenhagen Market; 7, Allhead Early; 8, Improved Allhead Select; 9, Charleston Wakefield; 10, Surehead; 11, Succession; 12, Louisiana Copenhagen.

PLATE 1.

PLATE 2.



TEXT FIG. 1. Layout of the cabbage culture during the 1937–1938 season at the Los Baños Economic Garden, Los Baños, Laguna: 1'—25', plant numbers in the row; 1, Early Stonehead; 2, Copenhagen Market; 3, Allhead Early; 4, Improved Allhead Select; 5, Charleston Wakefield; 6, Surehead; 7, Succession; 8, Early Summer; 9, Autumn King; 10, All Seasons; 11, Enkhuizen Glory; 12, Premium Flat Dutch; 13, Early Flat Dutch.



TEXT FIG. 2. Layout of the cabbage culture during the 1938–1939 season at the Los Baños Economic Garden, Los Baños, Laguna: 1, Golden Acre; 2, Wisconsin All Seasons; 3, Early Summer; 4, Premium Flat Dutch; 5, Enkhuizen Glory; 6, Copenhagen Market; 7, Allhead Early; 8, Improved Allhead Select; 9, Charleston Wakefield; 10, Surehead; 11, Succession; 12, Louisiana Copenhagen.

NOTES ON DISEASES AFFECTING MAIZE IN THE PHILIPPINES [1]

By Gaudencio M. Reyes

Plant Pathologist
Bureau of Plant Industry

SIX PLATES

In the latter half of 1939 and during the first three quarters of 1940, the outbreaks of some interesting diseases of maize were noted in the fields appearing in varying degrees of severity. Four of these diseases, the brown spot, anthracnose, dry ear rot and pokkah bong, do not appear to have been reported from the Philippines heretofore. The occurrence this year of unusually ideal weather conditions, with special reference to long stretches of unceasing rains, has greatly conduced to their development. In the absence of a thorough survey it has not been possible to make accurate estimates of the aggregate injury sustained by this important cereal, but the downy mildew which recurs annually in some sections of the country causes serious losses on this economic crop.

The present paper attempts to present the results of observations and experiments made recently on these maize diseases which have come to the attention of the writer. More expanded accounts of these diseases will follow later.

DOWNY MILDEW

Downy mildew continues to be the chief scourge of our maize industry in certain parts of the country. Field surveys made in Batangas Province undoubtedly showed that the downy mildew of corn was decidedly more abundant in 1940 than in 1939. It is also present in Pampanga Province. Epidemics of great severity causing as much as 100 per cent infection in extreme cases (plate 1) have been found in some localities. On account of prolonged rainy season coincident with the growth of corn, the downy mildew developed at a rapid rate.

[1] Received for publication November 27, 1940.

Symptoms, signs, and cause.—This disease which is locally known as "pute" (Tagalog), meaning white, is recognized by the appearance of yellowish or whitish stripes at the base of the upper leaves. These stripes may be produced at varying lengths toward the tip and some leaves are completely yellowed. On some plants the upper leaves lose their entire green color, and occasionally entire plants are completely whitened through loss of chlorophyll as if they are albinos. The unmistakable sign of the disease is the presence of a white down on chlorotic areas on the surface of the leaves. Plants attacked are stunted and blighting or death usually occurs on young plants. The causal organism is *Sclerospora philippinensis* Weston.

Factors favoring spread.—It is not definitely known how this infectious fungus persists from year to year. Observations show without doubt that the fungus is easily disseminated, especially by wind and insects, and that the increasing prevalence of the disease in any one year is due mainly to the apparent apathy of the growers to remove and destroy at once or as soon as noticed all diseased plants. This step is of vast importance on account of the fact that the rouged out plants once allowed to dry up in the sunshine would no longer transmit the disease to healthy plants. The diseased plants are so easily distinguished that there should not be any difficulty in carrying out measures towards preventing the persistence of the disease from crop to crop.

Control studies.—It is not improbable that by continuous selection in diseased fields, plants possessing some inherent resistance would be found. A few such plants have already been encountered and are now being tested in fields where the downy mildew was found to be serious in the preceding season. Out of the six selections planted, one showed complete freedom from the disease, while the others had 2.7 per cent to 5.4 per cent infection, in comparison with the other varieties planted nearby which all showed susceptibility in varying degrees, ranging from 7.5 per cent infection in Cebu White to 31.5 per cent in Bauan Pula. Sweet corn appeared also as one of the most susceptible varieties.

It has also been determined by experiment, supplemented by actual field observations, that the time of planting has a lot to do with the occurrence and severity of the downy mildew. Plantings made on May 29, June 13 and July 3, or at intervals of about a fortnight, revealed that the earliest planting done on May 29, 1940 suffered the least amount of damage, the damage

becoming much worse in later plantings. Those planted on July 3 were a complete loss. It stands to reason therefore that to save the bulk of the crop it is better to sacrifice a few diseased plants.

Field observations on plantings of a progressive farmer made by actual counts of downy mildewed plants per 100 square meters of unit area corroborated very substantially the experimental results. The planting which was done on June 1, 1940 had only .51 per cent infection. That made on June 14 sustained 85 per cent infection, while the latest planting made on July 3 was declared a total loss. From these results it could be readily deduced that one of the most feasible avenues towards reducing to the minimum, if not to eliminate altogether, the sources of annual damage is to educate the farmers or promulgate some sort of a local legislation whereby all growers would be compelled under penalty of law (to be known as "Plant Protection Ordinance") to do all corn plantings about the same time, the planting time not to exceed one week, say from May 15 to 21 or from May 21 to 28, depending upon the prevailing weather conditions. In other words, the provisions of the law governing corn planting should be determined every wet season, depending upon the availability of rainfall obtaining in an infested province or region.

In a preliminary way it has also been determined that plantings made in October which coincide with the drier months were not affected by the downy mildew even in the presence of abundant sources of infection. This tends to show that weather conditions have a great deal to do with the outbreaks and severity of the disease. Further trials to be conducted in severely infested corn fields during the dry season will show more definitely how much damage the downy mildew can do. But even if the downy mildew could be eliminated altogether during the dry season, it is not advisable to advocate a change of planting season, because the dry-season corn crop yields generally less than the wet-season crop. Provided, however, that irrigation is practicable, and with the help of some complete fertilizers, dry-season planting can be made as profitable.

It also appears that the more or less depleted condition of corn lands, especially in Batangas Province due to continuous cropping, where intercropping with rice, another cereal, is a general practice, affords the downy mildew all the chances to do much damage, because the plants become very easy victims due to their lowered resistance. Aside from this fact, the plant-

ing of corn at different intervals during the wet season affords the disease a chance to maintain a continuous supply of ample fresh inoculum of increasing virulence, thus giving the disease the opportunity to develop everywhere and cause widespread destruction.

BROWN SPOT

The brown spot (plate 2) which has been seen in the Philippines for the first time is an important disease of corn. How long this disease has been here is not known, but the chances are it has been here unnoticed for some time in a mild form but became so prevalent and severe in 1940 that it attracted attention. Specimens of the disease obtained from the provinces of Rizal and Pampanga have been examined and were found to be identical in all respects. The disease attacks the leaves, both blades and midrib, sheath, stalk and ear. Infection is usually more abundant on the lower half of the plant and on the older and lower halves of leaves. It weakens the plant and reduces the yield by the restriction of normal physiological functions, and the infections at the nodes cause the plants to lodge.

Symptoms and cause.—The first sign of the disease on the leaves is the appearance of minute yellowish oblong spots, less than a millimeter in diameter. Bigger spots are found by fusion of two or more spots. These turn gradually orange-yellow and then reddish-yellow. They are very numerous, visible on both sides, scattered mostly from the base to half the length of the leaf, imparting to it in a slight degree a rusty appearance. In fact it is sometimes confused with the true rust, caused by *Puccinia sorghi* Schw.[2], which is distinctly different.

On the midrib the spots are 1–3 mm. in diameter, somewhat circular, chocolate brown with a reddish or reddish-purple area around, and are bigger than those found on the blades. They are not as clear or as bright in color on the lower surface.

On the sheath the brown spots are similar to those on the midrib, but irregular in shape and generally bigger. Infection spreads at the margin of the spots as if blotting in appearance. Occasionally the spots have a reddish surrounding. Very severe infection occurs where water accumulates.

On the stalk, the spots are also dark brown and with a tendency to elongate, occurring generally at the base of the leaf sheath or below, scattered around the node. This nodal in-

[2] Reyes, G. M. Maize rust in the Philippines. Phil. Agr. Rev. 17 (1924) 1:3–9. 4 pls.

fection causes the stalk to become brittle and break readily with a gust of the wind.

The outer ear husks are affected at the tip or margin usually at the side of the ear adjoining the culm. The spots produced are small and very much like those found on the leaf. Infection of young developing ears inclosed by sheaths showed the brown spots which probably arrest the growth of the ears.

This disease is caused by an obligate parasite of the phycomycetous group, *Physoderma zeae-maydis* Shaw, bearing very thick-walled orange sporangia.

Inoculation experiments.—Various methods of artificial transmission have been tried in the field: (1) by placing pieces of brown-spotted leaves at the basal end of healthy sterilized leaves and then covering them with a transparent wax paper, supplying extra moisture by means of a wad of cotton saturated with sterile water; (2) by inserting pieces of infected sheaths showing ruptured epidermis in between a healthy leaf sheath and the stalk; (3) by pasting on the outside of sterilized healthy leaf sheaths wet fragments of brown-spotted sheaths showing abundant sporangia and then covering with wax paper, and supplying also adequate moisture; and (4) by pouring dilutions of sporangia into the tops of young healthy plants about a meter in height.

All inoculations were done during rainy days on sweet corn, but the most successful ones were those conducted by spore dilution. Typical symptoms of the same disease developed in about two weeks.

Factors for development and spread.—The uniform distribution of rainfall coincident with the early susceptible period of growth of corn, together with high temperature and humidity, which prevailed in 1940, especially during August and September, were ideal conditions for the growth and development of this disease.

By rupture of the epidermis, ample spores are liberated as brown dust and may then be disseminated to other plants by various agencies, such as wind, rain, running water, insects and by man.

Control.—The most important consideration in the control of this disease is the reduction of sources of infective units. It is advisable, therefore, to destroy at once all infected plants before the spores are liberated, i. e., before the infected parts are ruptured through the epidermis. All plant refuse should be burned completely after harvest. Diseased plants removed from the

field should not be used for fodder, because the thick-walled sporangia would likely survive in the manure. Ears for seed should be secured from disease-free fields.

Crop rotation should be practiced, and land previously planted to corn where the disease was prevalent should lie fallow for not less than two years. Growing corn continuously in the same sick field will only cause more and more damage.

The possibility of controlling the disease by selection of resistant strains or by variety resistance test is worthy of consideration.

POKKAH BONG

A disease of maize closely similar to that of sugarcane is the pokkah bong, perhaps the least known disease of this crop in the Philippines. It has been observed occasionally, but apparently nothing has been published about it, because diseases of maize have been for some years a neglected phase of phytopathological investigations. Recently, however, maize pokkah bong was encountered again on sweet corn during the rainy month of August, 1940, and for this reason it is here recorded for the first time. It is quite readily recognized by the malformed tangled top, undergoing a certain stage of decay, which upon examination will reveal the presence of abundant *Fusarium* spores.

The affection of the tassel may deprive the plant of fertilizing material. It stunts the top and arrests further emergence of the tassel or new leaves, and is finally followed by premature death of the growing point.

Symptoms.—The most distinct characteristic of this disease is the shortening of the leaves at the top which are distorted and tangled at the tips and margins, becoming brown in advanced stages (plate 3). The infected leaves are lighter in color and are corrugated and curved upwards. Sometimes the developing tassel is also affected and fails to grow. Examination of the inner tissues shows slight yellowing or browning of the affected parts. A top rot may develop emitting a rather obnoxious putrid odor. The appearance varies according to the severity of the disease. Isolations made from fresh invasions yielded invariably a *Fusarium* organism, agreeing essentially with that of *Fusarium moniliforme* Sheldon causing the pokkah bong of sugarcane, both in cultural appearance and morphological characters.

Control.—During rainy weather the spread of this disease is greatly favored. It is therefore necessary that the diseased plants should be destroyed as soon as possible, in order to prevent the transfer of the infective material by insects and other agencies from diseased to healthy plants.

DRY EAR ROT

One of the diseases affecting the ear, the dry rot, possibly caused by *Physalospora zeicola* Ell. & Ev., (=*Diplodia frumenti* Ell. & Ev.), is quite common in the Philippines. It is generally known as ordinary black mold to growers, but in reality it is caused by a specific organism the parasitism of which is not yet thoroughly understood. The first inoculations made with a pure culture on the ears of Lagkitan at the dough stage in the field proved that the disease can be artificially reproduced.

The presence of this disease reduces the economic value of corn, and the preponderance of stromatic masses of the fungus on the ovary side of the grain may impair its power of germination. It would also cause damage to the milled product.

Signs of the disease.—The presence of the disease is not usually recognized until harvest time on dehusking the ears. The presence of rather small, blackened kernels, and of a number of shiny black, irregularly shaped protuberances around the exposed portions of the horny endosperm (plate 4) are unmistakable signs of the presence of this Diplodia ear rot. It appears more conspicuously on the white than on the colored varieties. By separating some diseased kernels from the cob, it will be seen that the kernels are usually more severely affected on the ovary surface. Upon breaking open a few infected ears, there are clear indications that the seat of infection is either through the silk or the cob stalk, since the blackening effect of the fungus on the pith and other interior tissues may start from either end, or possibly from both. Thus it seems apparent that the infection of the kernels originates generally in the infected cob.

Control measures.—The most promising consideration in the control of this disease is the selection of clean, healthy seeds. Rotation of crop should be practiced in localities much subject to the disease. The destruction of infected trash is very beneficial, as this will remove all sources of infective material.

ANTHRACNOSE

A disease which does not appear to have ever been noticed before in the Philippines is the maize anthracnose. The first

time that this disease was accidentally noticed by the writer was in a maturing field of corn in Rosario, Batangas, on July 3, 1940, which was also infected with the downy mildew. Some of the leaves which were found infected with the disease had also the yellow leaf stripe, hence the impression that it might be only secondary. After making further observations, however, *Colletotrichum* spots were also found on leaves or leaf areas unaffected by the downy mildew. The most commonly affected variety was the Batangas Yellow Flint, commonly known in various sections by different local or vernacular names. Sweet corn, which is a foreign introduction, and Cebu White have been observed to be also affected by the same disease.

Description and cause of the disease.—This undescribed disease affects not only the leaf (blade and midrib) but also the leaf sheath. The spots on the blade are scattered and generally elliptical, varying in size from that of a pinhead to that of a spot more than a centimeter in width and about 3 centimeters in length. Bigger or longer spots may result through the confluence of two or more spots. Typical spots are like those shown in plate 5 which have an irregular dark-brown border with a light grayish center, appearing in the same pattern on both sides of the leaf. Dotting the surface of the old spots are minute black masses—the acervuli—which upon microscopic examination would show groups of dark-brown setae and numerous somewhat crescent-shaped, hyaline, non-septate conidia.

On the midrib the spots are also elliptical, arranged in a row, with a great tendency to fuse together, thus forming much longer spots. They start as light yellowish-brown spots which on aging become visible on both sides. On the upper surface of the leaf, they are yellow or yellowish-brown having a dark brown border on both longitudinal sides. On the nether surface, the midrib spots are brownish-yellow but have also dark brown borders. Scattered over the spots are the black masses of setae and conidia.

On the leaf sheath the spots are usually long, having an irregular brown margin. The center is dirty yellowish-gray or grayish and is partly covered with black, sporulating masses.

The disease is attributed to a species of *Colletotrichum* whose morphological and physiological characters are being studied.

Infection experiments.—By means of the spore dilution method the causal fungus, a species of *Colletotrichum*, has been

successfully isolated in pure culture. Fresh cultures of the fungus, when introduced onto healthy, middle-aged leaves of standing corn, on both the native yellow flint and sweet corn, produced *Colletotrichum* symptoms similar in every respect to those found in the field. The recovered organism when used as inoculum yielded the same results. The fact has been fairly well established that the fungus that has been originally isolated is a pathogen of some potentiality. The inoculations made on sugarcane midribs and stalks in the field proved also that it is capable of inducing infection. Further work on this maize disease is in progress.

Control.—Sanitation methods directed towards the elimination of sources of fresh inoculum will help much in controlling the disease. It seems probable that a difference in the degree of reaction of varieties to the disease will be observed if a study is made.

BANDED SCLEROTIAL DISEASE

Another interesting disease, but has been rarely observed on maize, is the banded sclerotial disease. It occurs generally when a warm, humid weather prevails, but up to the present it appears to be as yet a disease of minor importance.

This disease resembles in many respects the banded sclerotial disease of sugarcane. It is closely similar also to the Rhizoctonia disease of rice, and the same fungus has been found on plants, particularly rice weeds of the Gramineae family.[3]

Symptoms.—This disease affects usually the older and lower foliage which come in contact with the ground or with leaves of other susceptible plants. It is characterized by zonate areas on the leaves (plate 6), which have a variegated hue of green, red and brown surrounding, with a wide, dirty greenish or grayish blotch in between. Under extremely favorable climatic conditions, the causal fungus, *Rhizoctonia solani* Kühn., develops quite fast and blotches may run over an entire leaf, reaching also partly the lower leaf sheaths.

Control.—Clean culture, plenty of aeration and sunshine, and the avoidance of interplanting with the susceptible plants will prevent the outbreak and recurrence of this disease in corn fields.

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[3] Reyes, G. M. Rice diseases and methods of control. Bureau of Plant Industry Farmers' Circular No. 50. 1939. 15 plates, 2 figures.

ILLUSTRATIONS

(Photographed by the Bureau of Science, Manila)

PLATE 1

Section of a corn field showing total destruction caused by the downy mildew as a consequence of late planting.

PLATE 2

Brown spot of corn in severe form, showing infections on the leaf and midrib, leaf sheath, ear husks, and shanks.

PLATE 3

Pokkah bong disease of sweet corn showing symptoms similar to those occurring on sugarcane. Note the destruction of the tassel.

PLATE 4

Portion of an enlarged ear of yellow flint corn infected with dry ear rot. Note the blackened kernels and the blister-like black structures around the exposed portion of the horny endosperm produced by the causal fungus.

PLATE 5

Anthracnose of maize affecting both the midrib and blade. Note the typical elliptical spots on the left side of the left leaf and midrib of right leaf.

PLATE 6

Banded sclerotial disease of maize, exactly identical with that produced on sugarcane.

PLATE 1.

PLATE 2.

PLATE 4.

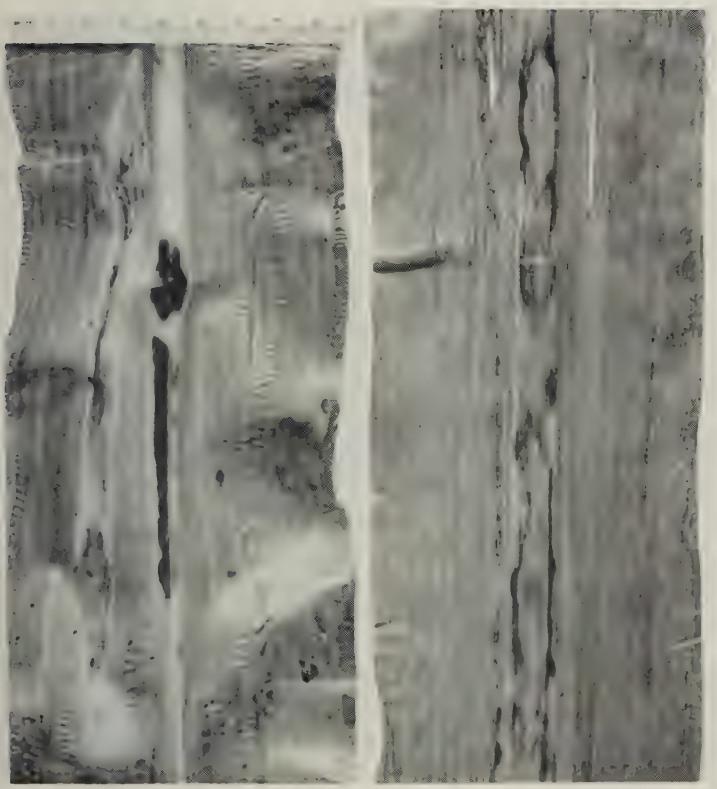

PLATE 5.

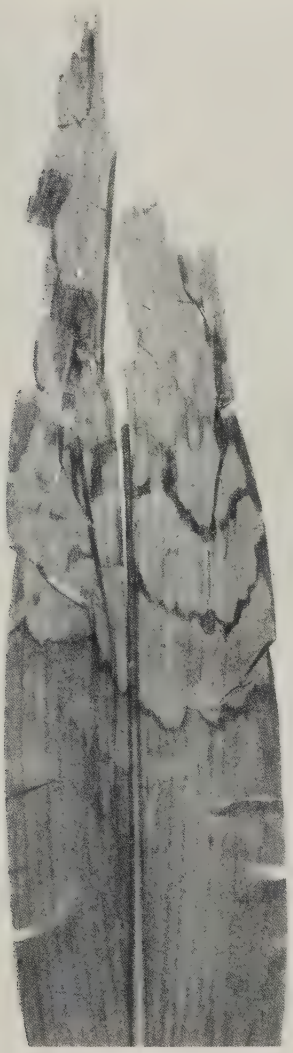

PLATE 6.

"FIBRESSEC," A NEW DOORMAT LOOM [1]

By Juan P. Torres and Fernando V. Cayaban
Of the Fiber Research Section, Bureau of Plant Industry

TWELVE PLATES

In the promotion of home industries in the Islands, the possibility of utilizing coir and the surplus fiber of abacá and maguey which is about to be produced in large quantities looms large and the Fiber Research Section of the Bureau of Plant Industry, aware of their economic value, is endeavoring to attain this government objective. In this connection, more new uses of the above-mentioned fibers and the different processes of manufacturing them into various articles of commercial value, as well as the different devices needed for their manufacture, had been the subject of study and research in the textile laboratory of the section. Already some favorable results along this line have been obtained.

In pursuing this objective, there has been recently worked out a device for weaving rope-doormats out of *abacá, maguey, coir* and other fibers, a device which is the subject of the present paper.

THE OLD AND THE NEW DEVICES

This new device is named "FIBRESSEC", which briefly stands for the name "Fiber Research Section". It is a device to help increase the production in the manufacture of this new type of doormat. With the "fibressec" device, a worker of average capacity can weave and finish one rope-doormat of ordinary size (about 16 inches x 25 inches) in about two hours. But, however fast the manufacture of these new type doormats is with the use of this new device, the old method of making doormats and skating mats with the looms and frames, as shown in plates 1 and 2, cannot be eliminated as these are of different patterns (plates 3 and 4), which are woven in these old devices.

The old looms, plates 1 and 2, had been adopted by the Bureau of Plant Industry since 1933 with some modifications intro-

[1] Received for publication December 16, 1940.

duced by Mr. Eugenio E. Cruz of the same Bureau. These types of looms have been used in instructing and teaching the numerous trainees and home demonstrators from different provinces in the art and process of making the pile weave doormats.

Weaving with the old devices.—The process of making the pile weave doormat with the looms shown in plates 1 and 2 may be briefly described as follows: Have the warp well stretched as in plates 1 and 2, allowing the highest possible tension at the warp ends. In order to produce good-quality doormat and for the convenience of the weaver in the process of weaving, the tensioning of the warp is very necessary.

To start the weaving operation, leave for finishing purposes a length of about four inches at the lower end of the stretched warp. This is done by weaving in three pieces of iron or wooden rod of $\frac{1}{2}$-inch diameter, and then setting in the plain type weave, over one warp under another, etc. In cloth weaving, this is called *heading*. After the heading, next to be woven is the lower selvedge of the doormat.

With a rope as big as the size of the warp and long enough to be used as *binder*, weave this in from right to left, and back in the same manner as in the *heading*. With a piece of blunt iron, beat or shove the interwoven rope close and tight to the heading. With the longer end of the binder rope at the right, wind it twice around the extreme warp to form the right selvedge. The weaving of the pile woof, bristle or coir wool is then done in the following manner:

Sort nicely the bristles by apportioning those with $\frac{3}{8}$ of an inch in diameter in each pick of coir by hand. Hook each apportioned bristle with each of the under-warp allowing or placing the two ends of the bristles to hang in front, then interweave the binder from right to left, placing now the over-warp as under-warp, the same as in the plain weave type, thus blocking the first row of pile woof or weft or fillings from unraveling. Drive close and tight to the lower selvedge the first row of woof by beating the binder with the blunt piece of iron.

Now to form the left selvedge, wind the binder at the left twice around the left extreme warp, as had been done with the right extreme warp. Hook again the pile woof of sorted and apportioned bristles as before, to each of the under-warp, and then interweave the binder from left to right placing the over-warp now as under-warp. Drive the second row of pile woof close and tight to the first row of filling by beating the binder in the same manner as had been done with the first. Then

cut evenly with a sharp knife the loose ends of the bristles used as weft, leaving the loose bristles or coir wool with about one-half inch in length or any length desired.

At this stage of the weaving operation, the weaver can readily see that the warp ends, except the left and right extreme warp ends, are alternately interwoven with pile woof and are securely bound together.

In setting the third row with pile woof at the right side of the bristles, wind the binder twice around the extreme right warp end as was formerly done, then hook the apportioned bristles as the pile weft to the under-warp as was done in the first row of pile woof.

The above procedure of interweaving the bristles or coir wool as weft and the binder alternately is followed till the desired size is reached. The weaving then finished, the warp ends are cut off leaving about three inches of loose ends. The loose ends then are knotted together close and tight to the upper and lower selvedges, thus finishing the doormat which is now ready for the market.

The new device.—The construction of the "fibressec" device, plates 5 and 6, is very simple. Even an ordinary carpenter can easily construct this new rope-doormat weaving device without difficulty from the specifications given herewith.

The distinct advantages of the "fibressec" device over the looms and frames, plates 1 and 2, in the manufacture of doormats are: (1) simple construction, (2) easy manipulation, (3) fast weaving and (4) low production cost of mat.

The base of the device is made up of two wood pieces, each measuring 2 inches x 6 inches x 3 feet long, B–B in plates 5 and 6. Two-inch-square holes are cut through the flat sides of these two wood pieces three inches from each of the ends, so that when the two wood pieces are put together side by side these end holes would fit together, and through which a tension block C–C, plates 5 and 6, could be slipped through. Provide the ends of each tension block with wood cutter, E–E, for tightening the two wood base pieces, B–B (plates 5 and 6), thus making it a clamping device. On top and at the junction of the two wood base pieces bore thirty $\frac{1}{2}$-inch holes 4 inches deep and $\frac{3}{8}$ inch apart. These holes are for holding or setting the thirty iron or wooden rods or pegs $\frac{1}{2}$ inch in diameter, 24 inches long, 1 to 30, plates 5 and 7.

These pegs serve as temporary warp or spokes for the doormat to be made. These pegs must be straight and smooth, so

that there will be no difficulty in removing them when the spokes are changed with the necessary rope for permanent warp.

HOW TO USE THE FIBRESSEC

To construct this new device is very simple. How to use it in weaving doormats is even simpler, so that one can weave a doormat on this new device even without much previous training. However, in the weaving of artistic and good-quality doormats the worker or the weaver must possess knowledge of the main fundamental weaves in loom weaving, namely, the plain, the twill, and the satin or sateen weaves. With the help of the illustration in plate 7, the following instructions on weaving a plain weave rope-doormat can be easily executed.

First, set the device by drawing apart the two wood base pieces, at a distance of about one-fourth inch. This is done by loosening the grip of the clamp. To do this, move upward the wedge-shaped wood cutters E–E, plates 5 and 6, at the ends of the base. Having loosened the grip of the clamp and the two wood base pieces already set apart, set in the 30 pegs standing in the 30 holes, then tighten the clamp again by forcing down the cutters thus holding the pegs firm and in straight standing position, ready for the weaving operation.

To facilitate the explanation of the weaving operation number the pegs from 1 to 30 from right to left. The weaver must also bear in mind that in ordinary plain weaving there is always an alternate inter-lacing of filling and warp over one and under another all the way through.

To start weaving, have the one end of the rope temporarily nailed as shown by the arrow at the extreme right end of the base in plate 7, allowing about six inches long for finishing. Pass the weft or filling behind peg No. 1, then in front of peg No. 2, then behind peg No. 3, then in front of peg No. 4, etc., until No. 29 is reached. At this stage of the weaving operation, the weaver finds that there is an alternate passing of the woof, in front and behind the pegs simultaneously. Pass the rope behind peg No. 29, then in front of peg No. 30, winding the rope once around the same peg, then in front of peg No. 29, then behind peg No. 28, etc., until peg No. 1 is reached. At this stage of the operation, the weaver again finds that the first return course of the filling has been done.

Upon reaching peg No. 1, wind the woof once as it was done in peg No. 30, then continue the weaving from the right to the left, following the course of the first woof. This process of

alternating the interwoven rope in the peg is continued until the desired width of the doormat is obtained.

The weaver must see further that when the end of the rope used as filling is at the lower right end of the base, the other end must stop at the upper left side of the woven doormat as shown in *a* and *b*, plate 8, or vice versa. As soon as the width of the doormat is reached (15″ x 24″, the standard size), the weaving of the doormat is only halfway through and to finish the doormat it is necessary to change the pegs with rope of the same diameter as or slightly smaller than the pegs. This rope will be the permanent warp of the doormat.

To change the pegs, detach the pegs with the interwoven ropes from the two wood base pieces, plate 10, by loosening the cutters of the clamp. Lay the pegs which are interwoven with rope on a table. The substitution of one peg after another with the rope is done by following the process shown in the illustrations (plates 8 and 10). Afterward, the loose ends of the filling and warp are properly and neatly fastened to the mat, thus finishing the doormat.

Artistic and fine-quality doormats such as those shown in plates 9, 10, and 11, woven on the "fibressec" device with the application of the three main fundamental weaves may be made with the use of a correct combination of fast dyed colored ropes.

ACKNOWLEDGMENT

The writers wish to acknowledge with thanks the criticisms, suggestions and drawings made by Mr. Severo Capistrano, acting chief, Agricultural Engineering Section, and Mr. Eladio Sablan, assistant agronomist, in charge of industrial researches on fiber.

ILLUSTRATIONS

PLATE 1

Pile weave doormat loom (nee frame).

PLATE 2

Reversible doormat loom.

PLATE 3

Samples of articles woven in the doormat looms.

PLATE 4

Back view of the pile weave doormat samples.

PLATE 5

The "fibressec" device, front view.

PLATE 6

The "fibressec" device, side view.

PLATE 7

How to weave rope doormat (plain weave) using the "fibressec" device.

PLATE 7(a)

The "fibressec" device, top view.

PLATE 8

How to finish the "fibressec" rope doormat by changing the pegs with rope as the permanent warp.

PLATES 9, 10, AND 11

Different weaves and patterns of rope doormats woven on the "fibressec" device.

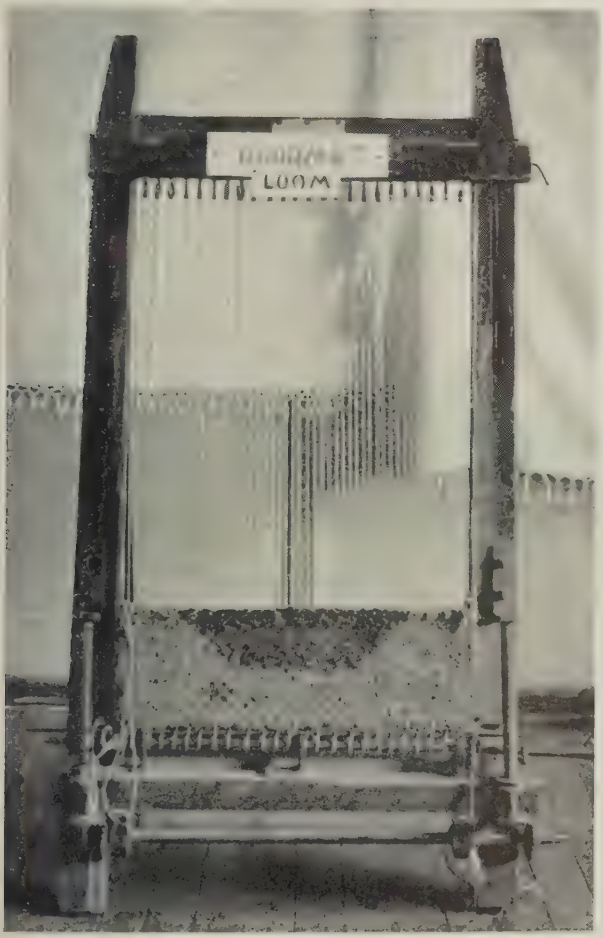

PLATE 1.

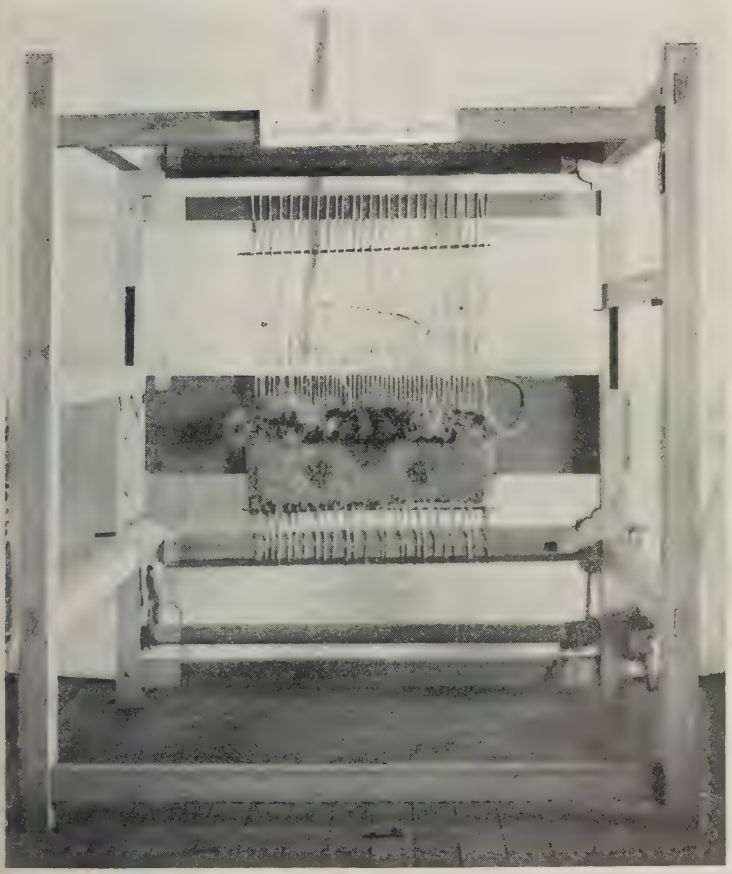

PLATE 2.

PLATE 3.

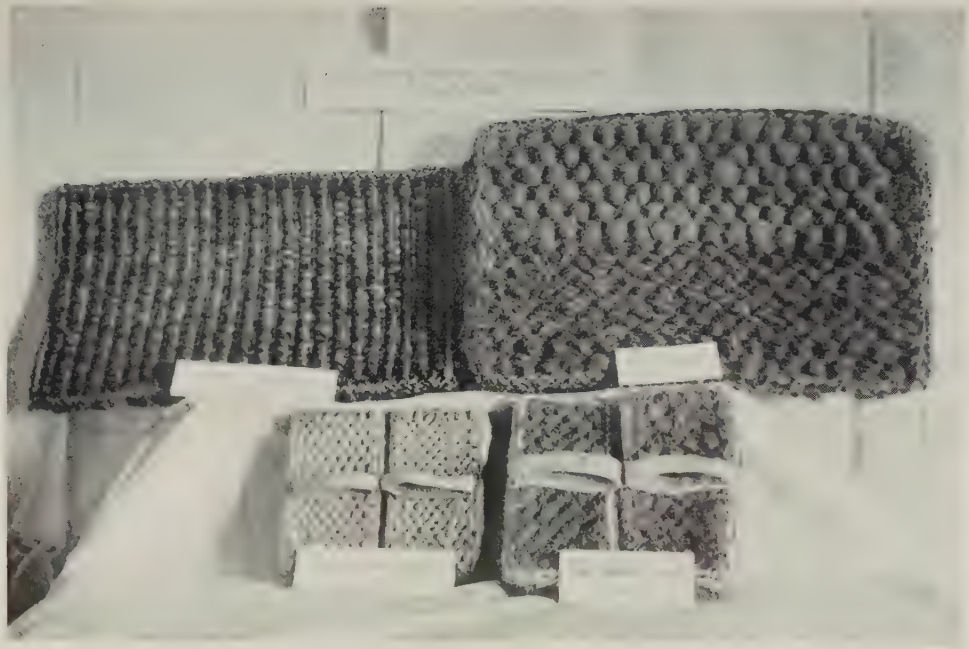

PLATE 4.

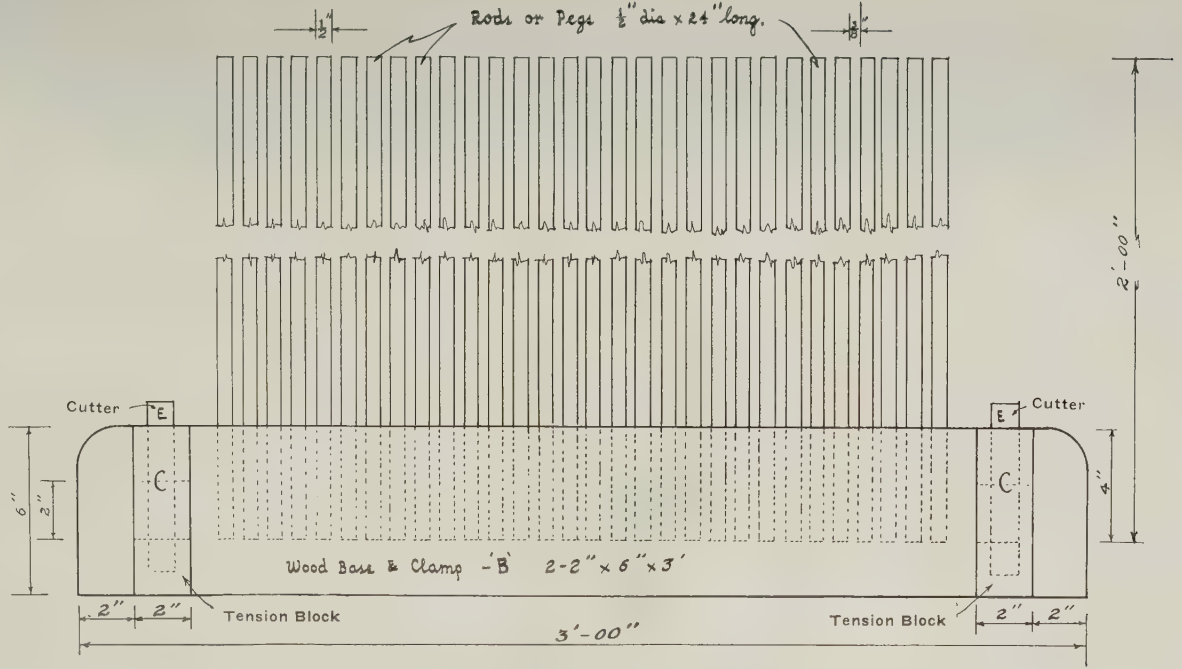
½"
Rods or Pegs ½" dia x 24" long.
⅝"
2'-00"
Cutter
E
E'
Cutter
C
C
6"
2"
4"
Wood Base & Clamp - B 2-2" x 6" x 3'
2"
2"
Tension Block
Tension Block
2"
2"
3'-00"

PLATE 5.

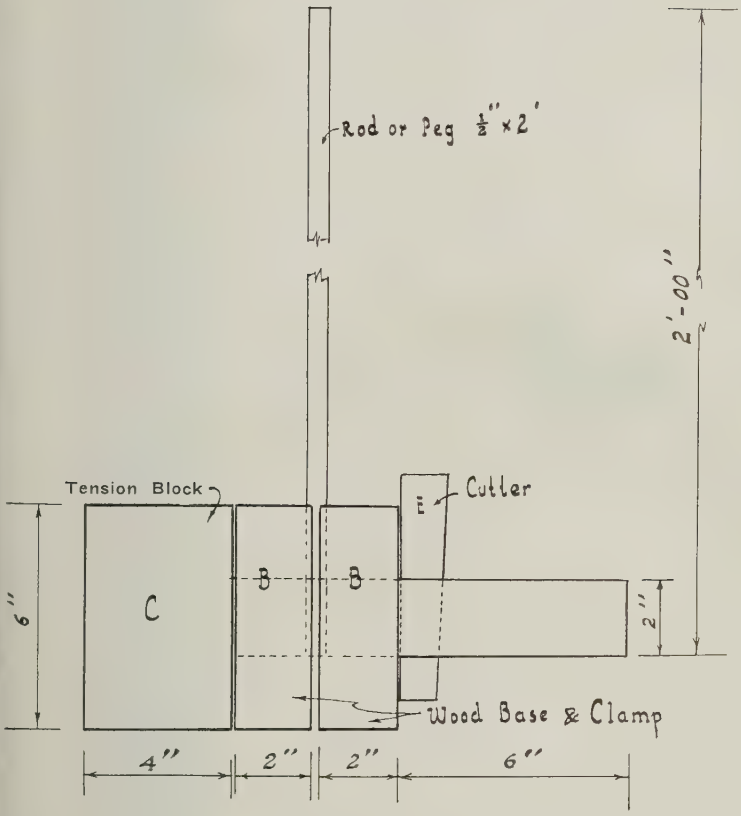
Rod or Peg ½" × 2'
2'-00"
Tension Block
Cutter
E
C
B
B
6"
2"
Wood Base & Clamp
4"
2"
2"
6"

PLATE 6.

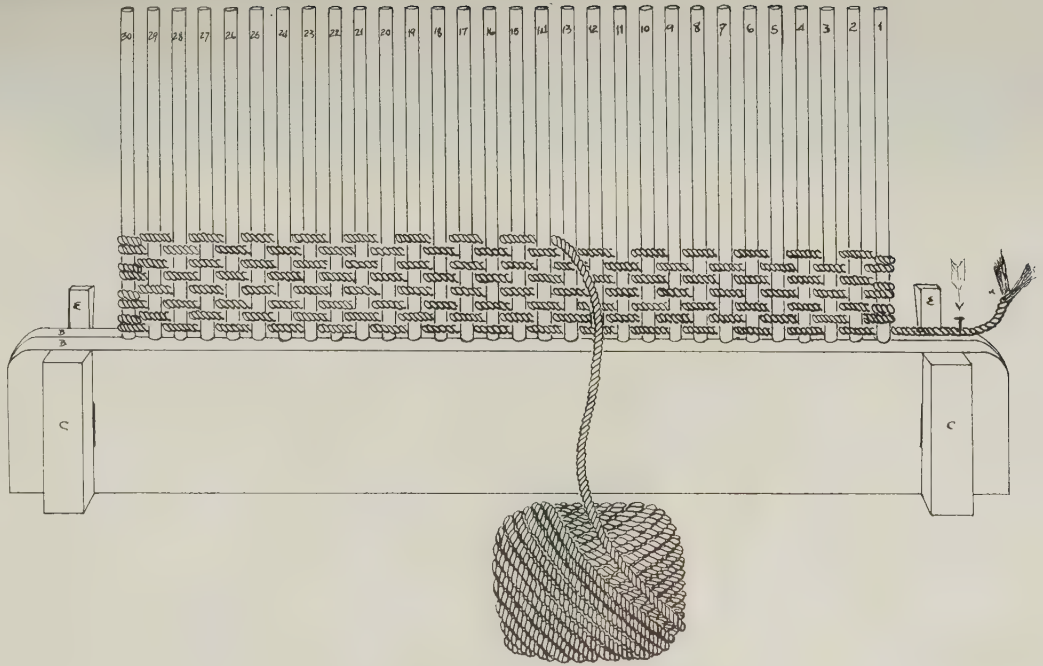
30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
E
E
B
B
C
C

PLATE 7.

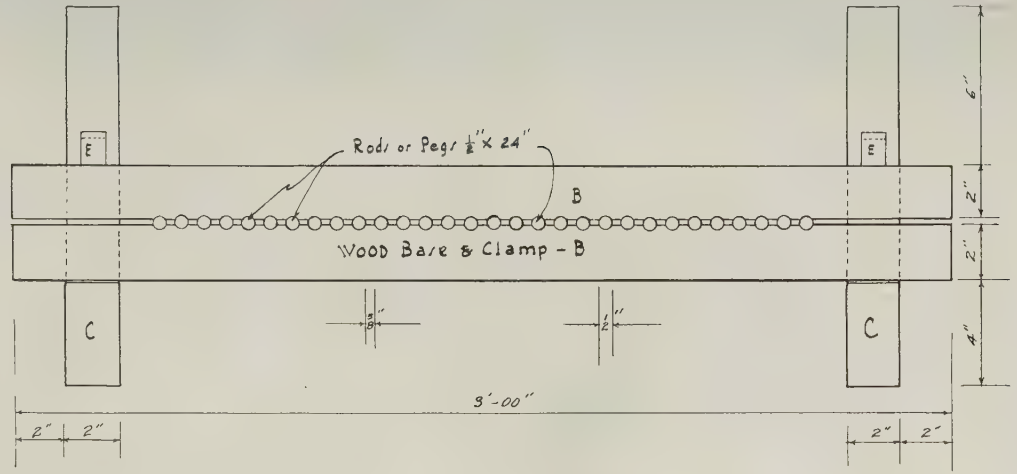

PLATE 7(A)

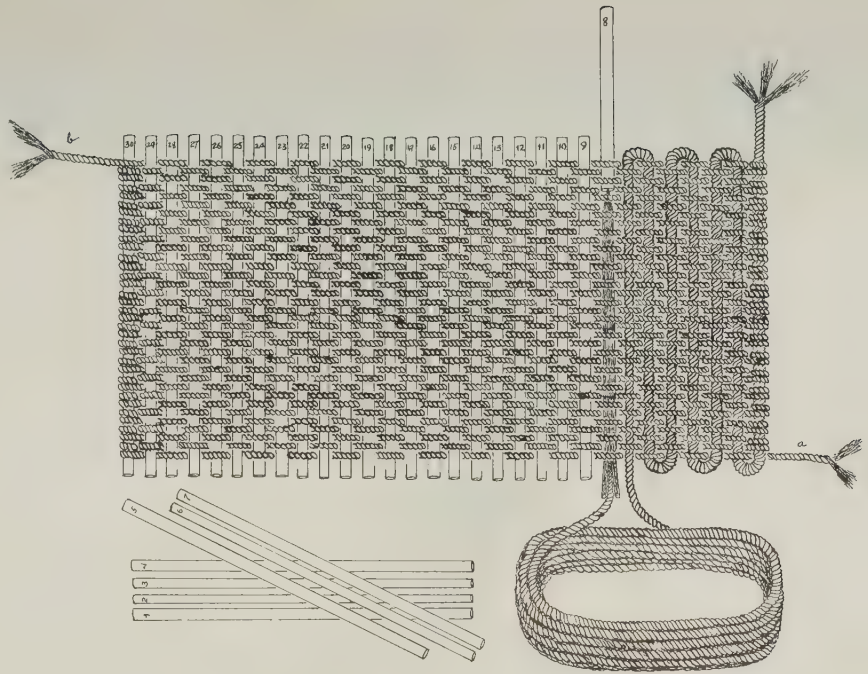

PLATE 8.

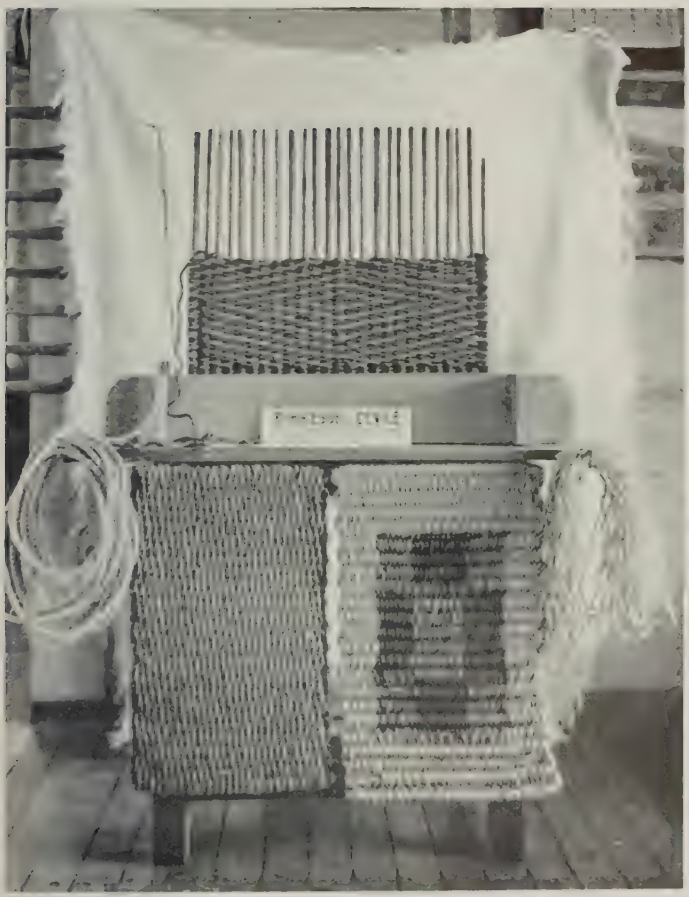

PLATE 9.

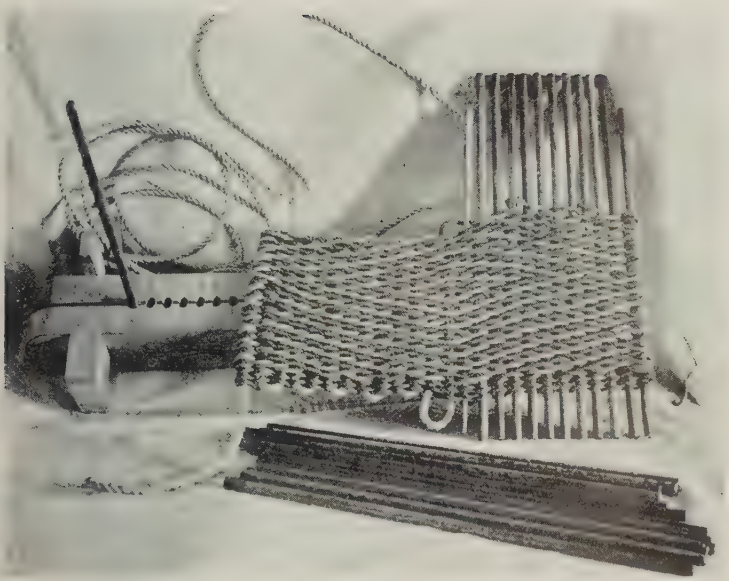

PLATE 10.

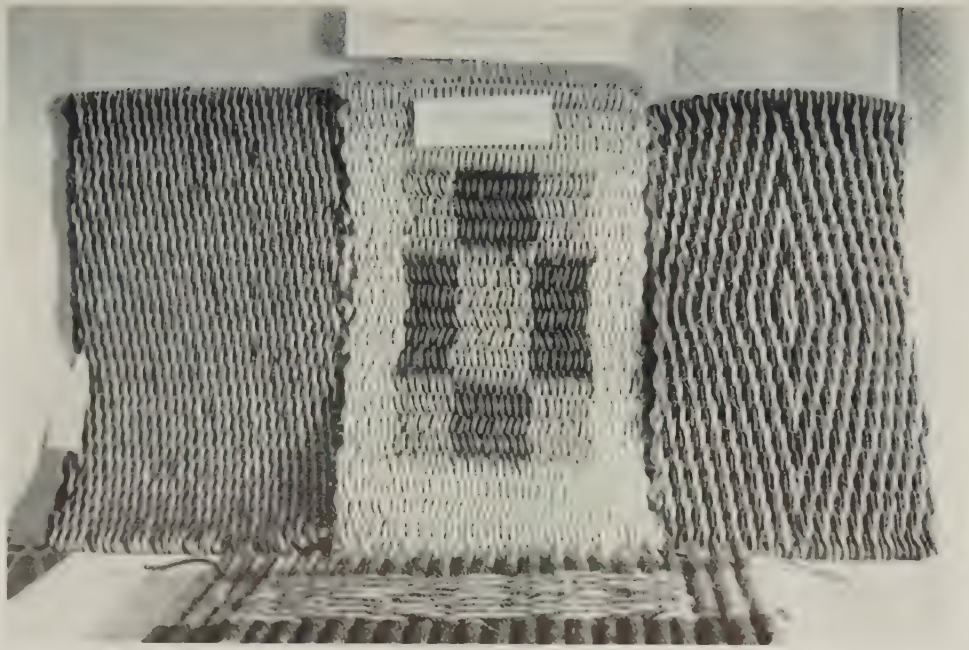

PLATE 11.

SOME NOTES ON THE TENSILE STRENGTH OF SILK FROM LOCALLY PRODUCED COCOONS [1]

By FELIPE CORTES and JUAN P. TORRES
Of the Fiber Research Section, Bureau of Plant Industry

FIVE PLATES

It may be stated that the raising of silkworms, *Bombyx mori* Linn., for their cocoons in the Philippines has already passed the experimental stage. In fact, in many places like Baguio, Mountain Province; Tanauan, Batangas; Batac, Ilocos Norte; La Granja, La Carlota, Occidental Negros; Ligao, Albay; Cavite, Cavite, and many other places, large numbers of cocoons have been successfully raised. The successful raising of cocoons in the Philippines may be attributed to the climate which is preeminently favorable to the culture of silkworms and to the growing of the silkworm feed, mulberry tree, *Morus alba* Linn. Apparently, silkworm raising in the Philippines, if properly organized, would be an attractive household industry.

Statistics show that there has been a steady increase of imported silk and its manufactures from over 4 million pesos in 1933 to over 6½ million pesos in 1939, representing a very heavy drain on our national coffer. On the basis of favorable conditions obtaining in the Philippines for the culture of silkworms and the large amount of silk importation, it may be advisable to promote and develop our silkworm industry, in the meantime that researches on the possibilities of artificial silk or rayon production which seem to be very successfully done in other countries are carried on in this country. Before such promotional work on natural silk culture is done, however, it is important to know the quality of silk obtained from locally produced cocoons.

The present paper presents some results of studies on the comparative tensile strength of different varieties of locally produced silk together with two imported kinds, the bleached silk No. 30 and the jusi No. 7.

[1] Received for publication November 27, 1940.

The experiment was conducted in the Fiber and Textile Laboratory, Fiber Research Section, Bureau of Plant Industry, Manila during the first quarter of 1939.

MATERIALS AND METHOD

The following local raw silk materials were studied: Albay Yellow, Albay White from Ligao, Albay; Cavite Yellow from Cavite, Cavite; and the B. P. I. Yellow and B. P. I. White raised at the Bureau of Plant Industry Silkworm Laboratory, Manila. The imported kinds were the jusi No. 7 and the bleached silk No. 30 from a local importer in Manila. In the naming of variety of silk the "yellow" silk means silk from the yellow cocoons and the "white" silk from the white cocoons. Many attempts at securing cocoons raised from other local sources failed, thus limiting this study to five varieties of silk of local origin and two imported ones.

In this connection, it may be stated that the silkworm strain producing yellow cocoons was introduced some time ago from Ceylon and that which produces the white cocoons was obtained from a Japanese concern in Baguio; presumably it originated in Japan.

Silk reeling.—The fresh cocoons not older than a week were first dried in the sun to kill the pupae. The damaged or destroyed cocoons were discarded. Using the warm-water immersion method, the different silks of local origin were reeled separately by means of a one-hand reeling machine (plate 1) with an approximate speed of 600 R. P. M. In order to minimize the error due to different individual operators, only one reeler was employed throughout the reeling process. Twenty-five cocoons of each variety were reeled each time to make a single thread of 25-silk filaments, so as to produce uniform yarn.

Number of twists.—Before testing for tensile strength, it is important to know the number of twists per inch of the different yarns. The results from five trials, including the counts for number of filaments in each yarn, are shown in table 1.

Tensile strength.—In the determination of tensile strength of individual variety of silk, five threads or yarns were used to make a sample strand. The Louis Schopper machine, with a capacity of 50 kilograms and 20 centimeters testing length, was

employed. The weight of each sample was determined by means of an analytical balance. Fifty trials were made for every variety of silk studied. The tensile strength of silk was determined in the usual way, i. e., by dividing the actual breaking strain in kilograms by the weight of the strand, 1 meter long in grams.

RESULTS

The original data on the weight of strand, 1 meter long, in grams, actual stretch of fiber in per cent, actual breaking strain in kilograms and the computed tensile strength of fifty trials for each variety of silk were not included in this report for obvious reason. However, the summarized data for the seven varieties of silk tested are shown in table 2; the minimum, maximum and the mean tensile strength in kilograms per gram meter are indicated. The mean differences and the statistical significance, i. e., mean difference over its probable error, are given in table 3.

TABLE 1.—*Number of twists and filaments of the different varieties of silk, average of 5 trials*

Variety	Actual number of twists per inch	Standard twists per inch	Average number of filaments per thread or yarn
Bleached silk No. 30	29.6	30 tw–in	161.6
Cavite Yellow	4.0	4 tw–in	25.0
B. P. I. White	4.0	4 tw–in	25.0
B. P. I. Yellow	3.8	4 tw–in	25.0
Albay White	3.8	4 tw–in	25.0
Albay Yellow	3.8	4 tw–in	25.0
Jusi No. 7	6.8	7 tw–in	46.6

TABLE 2.—*Tensile strength of different varieties of silk*

Variety	Origin	Tensile strength, kg. per gr. m.		
		Minimum	Maximum	Mean
Bleached silk No. 30	Imported	25.136	34.314	29.637±0.59
Cavite Yellow	Cavite, Cavite	25.087	33.784	29.285±0.59
B. P. I. Yellow	B. P. I. Lab.	25.801	31.369	28.655±0.41
B. P. I. White	B. P. I. Lab.	22.672	34.439	28.626±0.26
Albay White	Ligao, Albay	23.754	32.203	28.295±0.51
Albay Yellow	Ligao, Albay	21.843	30.788	26.187±0.42
Jusi No. 7	Imported	21.281	28.169	24.896±0.47

TABLE 3.—*Mean differences in tensile strength*

Compared varieties of silk	Mean difference	Difference /P. E.
Bleached silk No. 30 vs.—		
Cavite Yellow	0.352±0.83	0.42
B. P. I. Yellow	0.982±0.72	1.36
B. P. I.White	1.011±0.64	1.58
Albay White	1.342±0.78	1.72
Albay Yellow	3.450±0.72	4.79
Jusi No. 7	4.741±0.75	6.32
Cavite Yellow vs.—		
B. P. I. Yellow	0.630±0.72	0.87
B. P. I. White	0.659±0.64	1.03
Albay White	0.990±0.78	1.27
Albay Yellow	3.098±0.72	4.30
Jusi No. 7	4.389±0.75	5.85
B. P. I. Yellow vs.—		
B. P. I. White	0.029±0.49	0.06
Albay White	3.60 ±0.65	0.55
Albay Yellow	2.468±0.59	4.18
Jusi No. 7	3.759±0.62	6.06
B. P. I. White vs.—		
Albay White	0.331±0.57	0.58
Albay Yellow	2.439±0.49	4.98
Jusi No. 7	3.730±0.54	6.91
Albay White vs.—		
Albay Yellow	2.108±0.66	3.91
Jusi No. 7	3.399±0.69	4.93
Albay Yellow vs. Jusi No. 7	1.291±0.63	2.05

DISCUSSION OF RESULTS

In table 1 it can be seen that the different varieties of silk used in the tests vary not only in the number of twists per inch but also in the average number of silk filaments per thread or yarn. The imported bleached silk No. 30 shows the highest average number of twists (29.6 twists per inch) and the greatest average number of silk filaments (161.6 filaments). Very little variation in the number of twists is found among the silk of local origin, the twists per inch being about 4 and the number of silk filaments per thread being uniform at 25. The jusi No. 7 shows 6.8 twists per inch and an average of 46.6 silk filaments per thread.

Tensile strength.—A perusal of the data presented in table 2, which are arranged from the highest to the lowest mean tensile strength, apparently shows that all the local varieties of raw silk lie between the imported bleached silk No. 30, with a mean tensile strength of 29.64 ± 0.59 kilograms per gram meter and the jusi No. 7, with a mean tensile strength of 24.90 ± 0.47 kilograms per gram meter.

The results of comparative studies on the different varieties of silk in table 3 indicate that the first four local varieties of raw silk are almost as strong as the imported bleached silk No. 30, whereas the Albay Yellow was found to be only slightly stronger than the jusi No. 7, with an insignificant difference of 1.29 ± 0.63 kilograms per gram meter; compared with the other native varieties of raw silk the Albay Yellow was significantly weaker. The cocoons from which it was derived were relatively small and the silk filaments were more or less irregular and somewhat finer. The reason may probably be due to lack of feeds then available, because the silkworms were given insufficient amount of mulberry leaves during the last few days that they were about to form cocoons, and during the time that the silkworms were spinning their cocoons they were unconsciously disturbed. Obviously, it becomes apparent that good-quality silk is obtained from silkworms that are well fed and undisturbed during the spinning of their cocoons.

SUMMARY

These preliminary results of observation and experiments indicate that the varieties of raw silk produced in various places in the Philippines are of good quality as they were found to be as strong as the imported bleached silk No. 30, except the Albay Yellow which is insignificantly stronger than jusi No. 7.

The Albay Yellow silk showed a lower tensile strength than the other locally produced raw yellow and white silk because the silkworms were underfed and incidentally disturbed during the cocoon formation, apparently indicating that good-quality silk may be obtained from silkworms that are well fed and undisturbed while spinning their cocoons.

In view of the favorable environment for the culture of silkworms and because of the fact that in general good-quality silk may be raised in the Islands, with proper organization, silkworm raising may be made an attractive household industry.

ACKNOWLEDGMENT

Due acknowledgment is made of the help rendered by Mr. R. Ralla, Ligao, Albay, and the office of the Provincial Agricultural Supervisor, Cavite, Cavite in supplying the silk cocoons used in this experiment.

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ILLUSTRATIONS

PLATE 1

A complete outfit of the silk reeling machine used in the experiment. Note the woman operator working on the silk cocoons.

PLATE 2

A sketch indicating the passage of the reeled silk thread from the cocoons to the spool.

PLATE 3

Yellow cocoons (natural size).

PLATE 4

White cocoons (natural size).

PLATE 5

Raw silk filaments from yellow and white cocoons drawn under the microscope (H. P.). *a*, fibroin; *b*, layer of sericin, and *c*, shred of silk glue.

FIG. 1. Strong silk filaments from Cavite Yellow cocoons. (x 105 dm.)
2. Weak silk filaments from Albay Yellow cocoons. (x 105 dm.)
3. Silk filaments from B. P. I. White cocoons. (x 105 dm.)

PLATE 1.

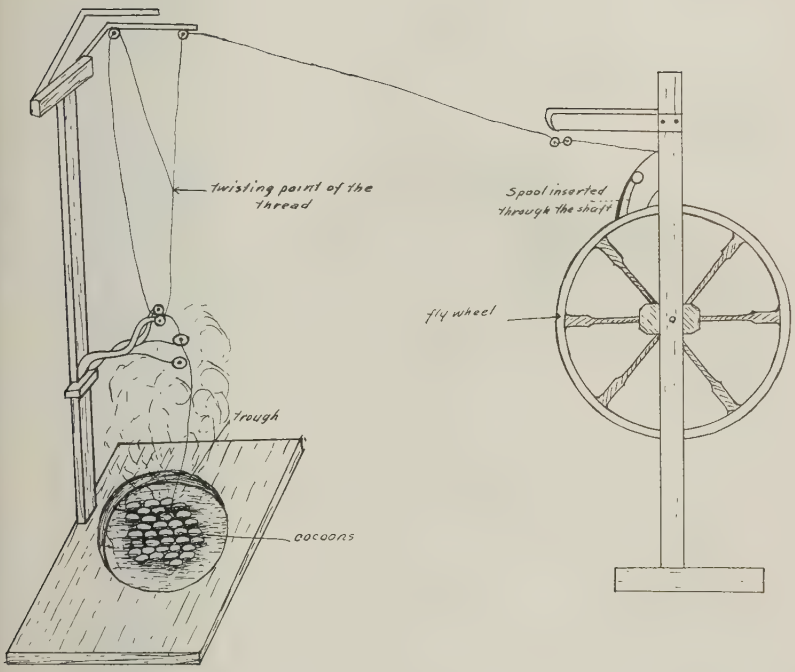
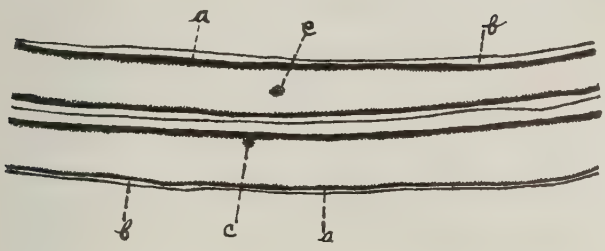

twisting point of the thread
Spool inserted through the shaft
fly wheel
trough
cocoons

PLATE 2

PLATE 3.

PLATE 4.



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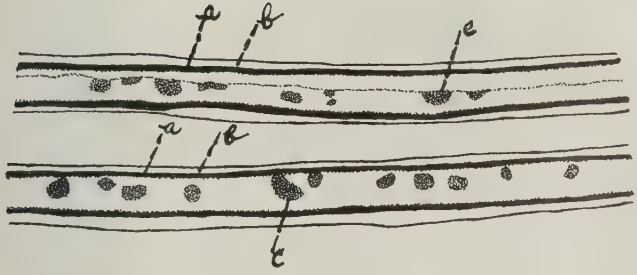

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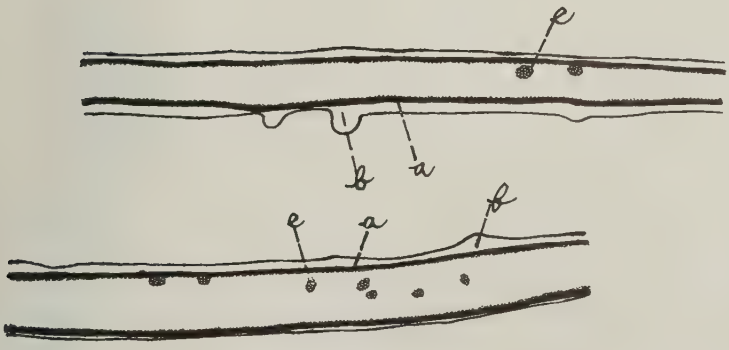

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PLATE 5.

CASHEW CULTURE [1]

By Emilio K. Morada [2]
Of the Horticulture Section
Bureau of Plant Industry

SEVEN PLATES

The cashew, *Anacardium occidentale* L., is a fruit nut that has long been grown in the Philippines but which has not received any serious attention from the growers. The increasing demand for its nuts as a raw material in the confectionery trade in the United States and in Europe and the recent utilization of the fleshy portion of the fruit in the manufacture of good-quality wine is attracting the attention of some planters in places well suited to its culture. This paper, therefore, was prepared to serve as a guide for farmers interested in the growing of cashew.

History.—Cashew is a native of tropical America, and today it is being cultivated in Africa, Brazil, Central America, Florida, India, Malabar, Madagascar, Malay Peninsula, Mexico, Peru, West Indies, Tahiti, etc. In the Philippines cashew is still of minor importance although it is found in many parts of the Islands. Its cultivation has so far been confined mostly around houses and very little care or attention is given to the tree.

There is no record of the time of its introduction into the Philippines. Undoubtedly it must have been brought here by the Spaniards from tropical America during the early days of the Spanish régime. What we know only is that cashew has been successfully grown in many parts of the Philippines especially in places where there is a distinct dry season, like Bataan, Bulacan, Cavite, Mindoro, Cebu, Nueva Ecija, Rizal, Pampanga, Zambales, etc. The planting, however, consisted only of a few trees around houses, and it was only recently that some large scale plantings in Bataan, Cavite, Rizal, Oriental Misamis, and Zambales were made. The areas, however, are not big enough to even supply the local demand for its nuts and fruits.

Description.—Cashew is an English name of the fruit tree known botanically as *Anacardium occidentale* L. It belongs

[1] To be reprinted as farmers' circular No. 38.
[2] Received for publication January 28, 1941.

to the family *Anacardiaceae* of which the mango is the most important species. The name was taken from the Portuguese word *caju* derived from the Tupi name *acaju* in Brazil. It is called *marañon* in Spanish speaking countries of tropical America; *pajuil* in Porto Rico; *jacote marañon* in Guatemala; *kaju* in India; and *gajus* in the Malay Peninsula. Locally it is known as *kasoy* in Ilocano, Tagalog, and Visayan; *balubad* in Pampanga; *maluko* in Pangasinan; *balkuke* in Ilocano; *balubar* in Tagalog; and *kosing* in the Mountain Province.

It is a small, spreading and evergreen tree of unattractive appearance with crooked branches and oftentimes very irregular crown (plate 2). The leaves are simple, oblong oval in shape with rounded apex and base, prominently veined, leathery, and are produced alternately on the twigs. The mature leaves are green, 12.5 to 18.0 centimeters long and 6.5 to 8.0 centimeters wide while the young ones are light brownish red.

The fruit is very peculiar (plate 6). It consists of the swollen receptacle known as the cashew "apple" and the kidney-shaped seed attached to the sunken part on the outside at the tip. The latter is known as the nut which furnishes the cashew kernel of commerce. In its natural position the fruit hangs with the nut at the very tip and the swollen portion or "apple" just above the seed. The "apple" makes up the greater part of the fruit, being 94 per cent while the nut is 6 per cent of the weight of the fruit. In the young stage, the nut is greenish and is very much bigger than the apple. As the fruit develops, the latter becomes very much larger than the nut and turns yellowish or reddish yellow on ripening while the nut diminishes in size and turns brownish or ash or brownish ash (plate 5). The "apple" is rather fibrous and juicy, with somewhat acidic and astringent taste. Table 1 gives an analysis of the food value of the "apple" as reported by Pratt and del Rosario of the Bureau of Science in 1913.

TABLE 1. *Food value of the cashew "apple" (Pratt and Del Rosario of the Bureau of Science, 1913).*

	Per cent
Waste	10.00
Water	86.00
Ash	0.37
Protein	0.71
Sugar	10.40
As sulphuric acid	0.23
As malic acid	0.32

In different trees under each variety the astringent taste varies which is rather peculiar. The kidney-shaped nuts attached to the tip of the "apple" are from 2.7 to 3.7 centimeters long, 1.5 to 2.5 centimeters wide and 1.3 to 3 centimeters thick. The husk or pericarp is a thick and rather hard cellular shell inclosing the white kernel. The latter is still covered with a thin light pink or reddish brown covering. The kernel is about 23 to 29 per cent of the weight of the nut while the pericarp constitutes 71 to 77 per cent. The kernel contains a high percentage of fat and protein which vary in different countries as may be seen in table 2.

TABLE 2. *Constituents of the cashew kernel as determined by chemical analysis in different countries*

	Philippines [1]	Hawaii [2]	India [3]
Moisture	3.71	29.48	8.1
Protein	21.56	14.44	7.6
Crude fat	46.52	41.57	12.3
Crude fiber	0.69	1.27	11.0
Starch	19.20		
Ash	2.33	2.59	1.8
Carbohydrates (N. F. E.)	5.99		59.2
Waste		70.52	

[1] Analysis by the Chemistry Section, Division of Plant Utilization, Bureau of Plant Industry.

[2] From Annual Report, Hawaii Agricultural Expt. Station, 1914.

[3] From Agriculture and Livestock in India. Vol. IX, Part 1, January, 1939.

As in mango, the flowers are produced in panicles generally at the terminal ends of the twigs (plate 4). When the tips of the bearing twigs are destroyed or cut, the flower panicles appear at the sides near the broken tips. Each panicle consists of 3 to 11 flower stalks depending upon the vigor of the tree. There are from 40 to 100 individual florets in a flower stalk or 120 to 1,100 flowers in a panicle or inflorescence. Two kinds of flowers, the staminate and hermaphrodite or complete, may be found in a panicle. The small number of complete flowers (from one to ten) in a flower panicle is one of the causes of the small number of fruits which develops in a flower panicle.

The flowers are small, light yellowish green, with 5 sepals, 5 petals and 12 stamens bearing fertile pollen. In an open flower, the separated tips of the petals turn downward parallel to the peduncle, thus assuming a cup-like shape. In a staminate flower, a stamen may be found protruding outside at the tip while the other stamens are inside the united portion of the corolla. In a complete flower, the stigma and one stamen are

protruding outside, the former being longer than the latter. The protruding stamen extends only to the base of the stigma just outside the corolla. The tip of the stigma is rather small and whitish while the tip of the protruding stamen which bears the anther is rounded and brownish.

Varieties.—As observed in the cashew regions of Bataan at harvest time, two distinct types or varieties may be segregated, namely, the yellow fruited variety and the yellowish red variety. Several strains of these varieties bearing several forms of fruit ranging from short turbinate to long turbinate or oblong may be found. In general, the fruits of the former are bigger and the taste is not so astringent as that of the latter. In table 3 may be seen a description of the fruits of the two varieties.

TABLE 3. *Description of the fruits of the varieties yellowish and yellowish red*

Character		Yellowish	Yellowish red
Weight of fruit	grams	121.0	90.0
Weight of flesh	grams	113.7	84.5
Length of "apple"	cm.	7.0	4.0
Diameter of "apple"	cm.	5.7	3.5
Weight of nut	grams	7.24	6.02
Length of nut	cm.	3.3	2.98
Diameter of nut	cm.	2.1	2.14
Thickness of nut	cm.	1.7	1.68
Weight of husk	grams	5.14	4.63
Thickness of husk	cm.	0.3	0.27
Weight of kernel	grams	2.1	1.39
Length of kernel	cm.	2.7	2.64
Diameter of kernel	cm.	1.1	1.17
Thickness of covering of kernel	cm.	0.3	0.23
Per cent "apple"		93.997	93.89
Per cent nut		6.003	6.11
Per cent kernel (based on nut)		29.005	23.08
Per cent husk (based on nut)		70.994	76.91

The other characteristics of the trees of the two varieties are similar so that the color of the ripe fruits so far is the only distinguishing characteristic.

Culture.—The culture of cashew does not involve a big capital outlay as many of its phases, such as cultivation, fertilization with commercial fertilizers, and intensive weeding may be dispensed with. In the Islands, in spite of the crude methods employed in its culture, many good-sized, beautiful cashew trees (plate 3) may be found in cashew regions. However, cashew trees respond easily to systematic cultivation.

The estimated expenses for growing cashew on one hectare (including the catch crops) from the first to the eighth year under Bataan conditions may be seen in table 4.

TABLE 4. *Estimated expenses for growing cashew on one hectare of land, from the first to the eighth year (Bataan Province)*

FIRST YEAR	
Clearing, burning, staking, and holing	₱43.00
460 cashew seeds at 10¢ per 100	.46
350 banana suckers at 5¢	17.50
One cavan of seed palay	3.00
Planting	11.00
Weeding	20.00
Harvesting and hauling palay	5.00
Threshing	4.00
Land tax	.87
Miscellaneous	5.00
Total expenses for first year	₱109.83
10 cavans of palay at ₱2	20.00
Net expenses for the first year	₱89.83
SECOND YEAR	
Weeding, pruning, disease, and pest control	₱30.00
12 gantas of Centrosema seeds at ₱0.50	6.00
Planting and replanting	1.30
Harvesting and hauling 250 bunches of banana	2.00
Land tax	.87
Miscellaneous	5.00
Total expenses for the 2nd year	₱45.17
250 bunches of banana	37.50
Net expenses for the 2nd year	₱7.67
THIRD YEAR	
Weeding, pruning, disease and pest control	₱30.00
Land tax	.87
Harvesting and hauling 600 bunches and 800 cashew fruits	6.00
Labor, small equipment and materials for making wine	12.00
Miscellaneous	5.00
Total expenses for the 3rd year	₱53.87
600 bunches of banana at 14¢ and 30 bottles of wine at ₱1.00 and 800 nuts at 5¢ per 100 nuts	122.40
Net income for the 3rd year	₱68.53

FOURTH YEAR

Weeding, pruning, disease and pest control and thinning of bananas	₱40.00
Land tax	1.60
Harvesting and hauling 500 bunches of bananas and 2,300 cashew fruits	6.50
Labor and materials for making wine	27.60
Miscellaneous	5.00
Total expenses for the 4th year	₱80.70
500 bunches of banana at 15¢, 92 bottles of wine at ₱1 and 2,300 nuts at 5¢ per 100 nuts	₱168.15
Net income for the 4th year	₱87.45

FIFTH YEAR

Weeding, pruning, disease and pest control and removing of bananas	₱50.00
Land tax	1.60
Harvesting and hauling 5,500 fruits	5.50
Labor and materials for making wine	66.00
Miscellaneous	5.00
Total expenses for the 5th year	₱128.10
220 bottles of wine at ₱1 and 5,500 nuts at 5¢ per 100 nuts	222.75
Net income for the 5th year	₱94.65

SIXTH YEAR

Weeding, pruning, disease and pest control	₱ 10.00
Land tax	1.60
Harvesting and hauling of 24,900 fruits	24.90
Labor and materials for making wine	274.80
Registration, license and fees	500.00
Miscellaneous	5.00
Total expenses for the 6th year	₱846.30
996 bottles of wine at ₱1.00 and 24,900 nuts at 5¢ per 100 nuts	1,006.25
Net income for the 6th year	₱159.75

SEVENTH YEAR

Weeding, pruning, disease and pest control	₱40.00
Land tax	1.60
Harvesting and hauling 36,500 fruits	36.50
Labor and materials for making wine	438.00
Wine house and bodega, equipment and supplies	2,000.00
Registration, license and fees	500.00
Miscellaneous	10.00
Total expenses for the 7th year	₱3,026.10
1,460 bottles of wine at ₱1 and 36,500 nuts at 5¢ per 100 nuts	1,477.25
Net expenses for the 7th year	₱1,548.85

EIGHTH YEAR

Weeding, pruning, disease and pest control	₱40.00
Land tax	1.60
Harvesting and hauling of 83,000 fruits	83.00
Labor and materials for making wine	996.00
Registration, license and fees	500.00
Miscellaneous	5.00
Total expenses for the 8th year	₱1,625.60
3,320 bottles of wine at ₱1 and 83,000 nuts at 5¢ per 100 nuts	3,359.75
Net income for the 8th year	₱1,734.15
Net income up to the 8th year	₱498.18

Soil and climatic requirements.—Cashew is not very selective as to the kind of soil in which it grows. It can grow in any kind of soil, from the richest to the poorest soil, as it can adapt itself easily to the existing soil, water, and climatic conditions. In the Philippines vigorous and productive cashew trees are found even in soil near the seashore and on reddish heavy clay soil a few meters above sea level provided it is well drained (plate 7). It thrives in almost any kind of climate found in the Islands at lower altitudes, but in order to make it productive there should not be too much rain during its flowering period.

Such kind of climate may be found in Bataan, Bulacan, Pampanga, Rizal, and Zambales, in fact, all the regions enjoying the first type of climate. It can stand drought to a remarkable degree without impairing its vigor and prolificacy. In the Islands, there is still a vast area, not suitable for other fruit trees but well adapted to cashew growing. A rolling land of second growth forest with stones or where the soil is too poor for other fruit trees may be planted advantageously to cashew.

Propagation.—The most common method of propagating cashew is by seeds. It can also be propagated by grafting and budding on its own root. However, the vegetative method of propagation has never been practised extensively since the seedlings bear fruits in a short time and they come more or less true to type. Besides, cashew seedlings do not stand transplanting very well. Hence nursery planting is not done. The seedlings are very hardy, fast growers, and can withstand a long drought.

Planting.—The land intended for cashew should be cleaned of its shrubs by cutting these down and burning them during the dry season as in *caingin* practice. After this, the land is laid out and the seeds are directly planted in the field 6 to 8 meters apart at the beginning of the rainy season. One to two seeds are placed in a hole 1.5 to 2.5 inches deep, but only one seedling should be allowed to develop in a hill. Seeds germinate in 15 to 25 days from planting. Four methods of planting—square, triangular, hexagonal and quincunx—may be employed. The first method is generally used as it is simple and easily made. The other three are harder to establish, but individually and with the same area and distance they can accommodate more plants than the first method.

Catch cropping.—At the beginning or during the first year, rice, corn, cassava, peanut, mungo, soybean, and banana may be interplanted. Banana is generally used, and in the first year rice and corn are also planted to give the grower some returns until the cashew plants bear fruits. From the second year on, it is not practical to plant any annual crop since the banana plants are already big by then. In the third year, the bananas may grow so thick as to shade the cashew plantings. When this happens, the bananas should be thinned so as to give the latter plenty of room for development.

Cover cropping.—In order to reduce as much as possible the upkeep of the plantation, a permanent cover crop such as *Cen-*

trosema pubescens, Calopogonium mucunoides, and *Indigofera endecaphylla* should be planted during the second year. The seeds of the first two crops may be broadcasted at the start of the rainy season, while the last may be propagated by cuttings. The cover crops suppress the growth of weeds and at the same time add plenty of humus to the soil, thus preventing soil erosion.

Weeding.—The cashew is a very hardy plant and can be grown with very little care. It is beneficial, however, to ringweed the young trees twice a year—at the start and close of the rainy season. As the cashew trees can combat successfully persistent weeds, like cogon, frequent weeding may be dispensed with. The weeds should be cut close to the ground with a sharp bolo while the cover crops should be kept away from the cashew trees. The cut weeds should be allowed to rot on the ground to serve as organic fertilizer to the trees.

Fertilization.—Because of the satisfactory crop given by a cashew plantation even in poor soil the question of manuring is not a problem in cashew growing. Even in India and other countries where it is grown commercially no systematic fertilization of cashew has been reported. Where permanent leguminous cover crops are planted between the trees, there will be less need of applying some commercial fertilizers. However, when the trees under normal conditions become somewhat stunted with rather yellowish green leaves producing only very few fruits some commercial fertilizers may be applied.

HARVESTING

Under Bataan conditions the harvesting season of cashew is from March to May. Ripe fruits can be distinguished by the yellowish color of the "apple." A device used in harvesting mango fruits may also be used in harvesting cashew fruits. The fruit is allowed to drop in the open string net attached to a small circular strong wire at one end of a bamboo pole provided with a cutter. Ripe fruits drop to the ground readily, hence they should be used immediately for the purpose intended, as in harvesting even a slight pressure will affect the thin delicate covering of the "apple" causing fermentation to set in a short time.

Cashew trees bear fruits in three years after planting (plate 1). They produce a few fruits at the start but these increase

in number as the trees grow older. The yield of cashew at the age of eight and nine years at the Lamao Experiment Station, Limay, Bataan is given in table 5.

TABLE 5.—*Yield of cashew at the Lamao Experiment Station, Limay, Bataan at the age of eight and nine years*

Year	Number of bearing trees	Age (years)	Date of harvesting	Yield in number of fruits			
				Minimum	Maximum	Average	Total
1939	347	8	March–June	5	1,620	211.09	73,251
1940	243	9	March–June	4	275	42.45	10,513
Total	590			9	1,895	253.54	83,764
Average	295			4.5	947.5	126.77	41,884.5

Good-sized trees give a maximum production of from 1,000 to 1,700 fruits with 7 to 15 kilos of nuts.

PESTS AND DISEASES

So far, there are comparatively a few insect pests and practically no important diseases known to attack the cashew in the Philippines. Of the insect pests, twig borers, mealy bugs, aphids, scales, and ants are the most important. The borers are found to attack the twigs. They deposit their eggs on any injured part of the twig. When they hatch, the larvae bore into the twig and live in the pith, going downward until they pupate. In this way the twig dies, thus lessening the fruiting area of the tree. The attack may be minimized by collecting and burning the affected twigs. The mealy bugs, scales and aphids suck the sap of young twigs and leaves. When the infestation becomes severe, the tree is weakened and the fruits may fall prematurely. They may be controlled by spraying with kerosene emulsion or nicotine sulphate solution. Big red and small black ants are found troublesome on cashew trees. Their greatest harm lies in the protection they give the mealy bugs, aphids and scale insects against the attack of their natural enemies. Their nests in the tree may be removed and burned or a lighted torch may be held under the nests to kill them. This system should be done continuously until the ants are eradicated.

Some birds, monkeys and wild cats may be found in some places to cause depredations by eating the ripe "apples." They can, however, be controlled by shooting them.

USES

The two important products of cashew so far known in the Philippines are the kernel and the wine from the fermented juice of the "apple" or fruit pulp. The kernel is used principally for making candies or mixed with ground roasted cacao seeds and sugar for the making of chocolate. It can be eaten raw but the roasted one is more delicious. Another important cashew product which is still undeveloped in the Philippines is "cardol." Cardol is the oil extracted from the shell of the nuts and is reddish brown in color. It is used in coloring fish nets, painting furniture, books, and other stationery to prevent the attack of insects, especially the silver fish. It is also used as external application for leprosy, ring worm and corm. It is a corrosive poison, the chief constituents of which are anacardic and gallic acids and cardol, a constituent which is named after the oil itself. Cashew shells contain about 35 per cent of this oil.

In India, the young leaves are used as tooth powder and brush. The acid in the juice prevents the decay of the teeth and keeps the gum in good condition. A decoction of the root is used as purgative. A good kind of oil which makes a good substitute for almond oil is extracted from the kernel. The residual kernel cake is either used as a fertilizer or as poultry feed. The juice which comes from the incisions in the bark can be used in the manufacture of indelible marking ink. In the Philippines, the cashew "apples" are either eaten fresh or made into salad. The young tender leaves are eaten as salad or for flavoring native fish dishes. The bark of the trunk is used for tanning fish nets or for coloring purposes.

PREPARATION OF KERNEL

Foreign markets demand kernels without shells or husks so that their preparation is an important factor in the industry. The different operations involved in the preparation as practised in India are as follows:

Roasting.—The nuts are first dried thoroughly in the sun. Then they are placed in an open iron pan over a closed earthenware furnace erected 3 feet above the ground and fed with cashew-nut shells. Enough nuts are placed in the pan each time for roasting. They are then stirred vigorously with long iron ladles to make the roasting uniform. Fire which soon starts on the shell may be easily extinguished by sprinkling a

little water over the nuts. Then the nuts are thrown on the ground with a simple lever adjustment. Before the nuts are collected for shelling, ashes are spread over them to dry out the oil which causes blisters on the skin of the shellers. In the roasting operation care should be taken to keep away from the vapor and smoke coming from the shells as they are injurious to the face and eyes.

Shelling.—The shell is removed by pounding the nuts lightly with a wooden peg or mallet. Women and grown-up children may be employed in this process. Shelling is done by contract with women at the rate of 4 centavos a kilo of whole kernel. The kernels constitute 25 to 30 per cent of the roasted nuts.

Peeling.—The shelled kernels are either partially dried in a specially constructed oven or dried in the sun to facilitate the removal of the skin adhering to the kernel. In the former, the kernels are kept for six hours at a temperature of 70°C. Higher temperatures are destructive because the kernels become too brittle causing much splitting resulting in a considerable loss, as only whole kernels are exported. Complete drying is effected in two days by exposing the product to the sun. The peeling is done by hand at a contract price of 2 centavos a pound of whole kernels.

Sweating.—The clean kernels are further subjected to a process of sweating to prevent breakage. They are placed in iron mesh trays over a closed cement tank of water. Upon heating, the steam arising from the water makes the kernels tough. The kernels are kept inside for 2 to 3 hours depending upon the weather conditions and the nature of the kernels.

Grading.—The kernels are graded according to size and quality as follows:

1st grade—whole, good, big-sized kernels.
2nd grade—whole, good, small-sized kernels.
3rd grade—halved and broken kernels.
4th grade—rejected and spoiled.

Only the first two grades are exported while the latter two are sold locally. In American markets, the 1st grade commands a higher price ($533 per ton) than the 2nd grade ($277 per ton).

CASHEW WINE PREPARATION

The manufacture of cashew wine was started by the Bureau of Plant Industry five years ago. Due to the simple and easy way it is prepared and its good taste which is becoming locally popular, cashew wine is bound to become a commercial product of importance in the near future. Its preparation as worked out by the Plant Utilization Division, Bureau of Plant Industry is as follows:

After removing the nuts from the ripe fruits, the "apples" are washed, chopped into pieces or passed through a wooden crusher to extract the juice. The remaining juice in the crushed fruits is further extracted with the aid of a wooden presser. For every four parts of juice one part of second class refined sugar is added. The sweetened juice is then heated to 60°C. after which it is placed in a demijohn to cool off. Then one-fourth cake of Fleischmann's wine yeast is added to every 15 to 20 liters or every demijohn of the cooled mixture. It is set aside to ferment from 7 to 11 days or until no bubbles of carbon dioxide gas are given off. The clear juice is then decanted and heated between 50° and 60°C. It is then set aside to settle for a month and then placed in a wine barrel for aging. It should be stored for at least a year, as the flavor is very much improved by aging.

About 500 fruits will make a demijohn of wine, and a demijohn contains sufficient wine to fill 20 bottles of one liter capacity each. The present local retail price is one peso (₱1) a bottle.

CASHEW NUT MARKET

Cashew kernel is consumed locally on a very limited scale due to lack of supply. Although it is more nutritious than the imported nuts, in 1937 alone various nuts amounting to 542,355 kilos valued at ₱107,167 were imported into the Philippines. This yearly importation may be greatly minimized by establishing the cashew nut industry and at the same time have an export trade in cashew kernels and wine. The United States imports cashew nuts worth seven million dollars mostly from Southern India. Besides, there is a big local demand for roasted kernels as a dessert, and for culinary purposes.

In India and Madagascar where there is a big forest of cashew, the exportation of cashew nuts or kernels is an important industry. The countries importing cashew kernels

from Southern India through the port of Cochin and the amount imported in 1935 and 1936 are given in table 6.

TABLE 6. *Countries importing cashew kernels from Southern India and the amount imported in 1935 and 1936*

Country	1935	1936
	lbs.	*lbs.*
United States	4,928,000	6,832,000
United Kingdom	15,456	134,400
France	12,320	19,264
Belgium	10,416	35,840
Australia	448	5,488
New Zealand	----------	68,544
Bombay	123,200	142,240
Total	5,089,840	7,237,776

The above table shows that cashew kernels are imported into the United States, Europe, and Australia. The former is the principal importer followed by Bombay (India) and the United Kingdom and the amount imported into the United States is very much greater than the total importation of all other countries. Table 7 gives the total amount and value of importations of kernels into the United States from various countries.

TABLE 7. *Total amount and value of importations of cashew kernels into the United States from British India, France, Italy, United Kingdom, Haiti, British East Africa and other countries of Asia, 1934–1937*

Year	Quantity	Value
	Kilos	*Pesos*
1934	6,772,342	4,698,52[2]
1935	10,171,105	7,317,720
1936	10,046,279	7,413,66[6]
1937	12,203,715	8,225,15[2]

It is apparent from the above figures that the importation increased considerably from year to year thus showing the fact that cashew is an important item of import in the United States, in spite of the four-centavo-per-pound duty that is being collected. Cashew, besides, is a noncompetitive crop in the United States.

This neglected fruit tree which has been and is still kept in the back yards for so long a time has, therefore, great commercial possibilities in the Islands. The cashew industry which

can be made to increase the income of the farmers and the revenue of our country can be developed easily.

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ILLUSTRATIONS

PLATE 1

A bearing three-year-old cashew plant. Lamao Experiment Station, Limay, Bataan.

PLATE 2

A nine-year-old cashew tree showing an irregular crown. Lamao Experiment Station, Limay, Bataan.

PLATE 3

A uniform low spreading crown of a nine-year-old cashew tree. Lamao Experiment Station, Limay, Bataan.

PLATE 4

A flower panicle at the terminal end of a twig.

PLATE 5

Different stages of the cashew fruit (left to right). Note the proportion of the "apple" and nut in the early and mature stages.

PLATE 6

Ripe cashew fruits showing the "apple" and nut.

PLATE 7

A good nine-year-old cashew plantation on rolling ground of slightly reddish clay soil about 700 meters from the seashore and 20 meters above sea level. Lamao Experiment Station, Limay, Bataan.

PLATE 1.

PLATE 2.

PLATE 3.

PLATE 4.

PLATE 5.

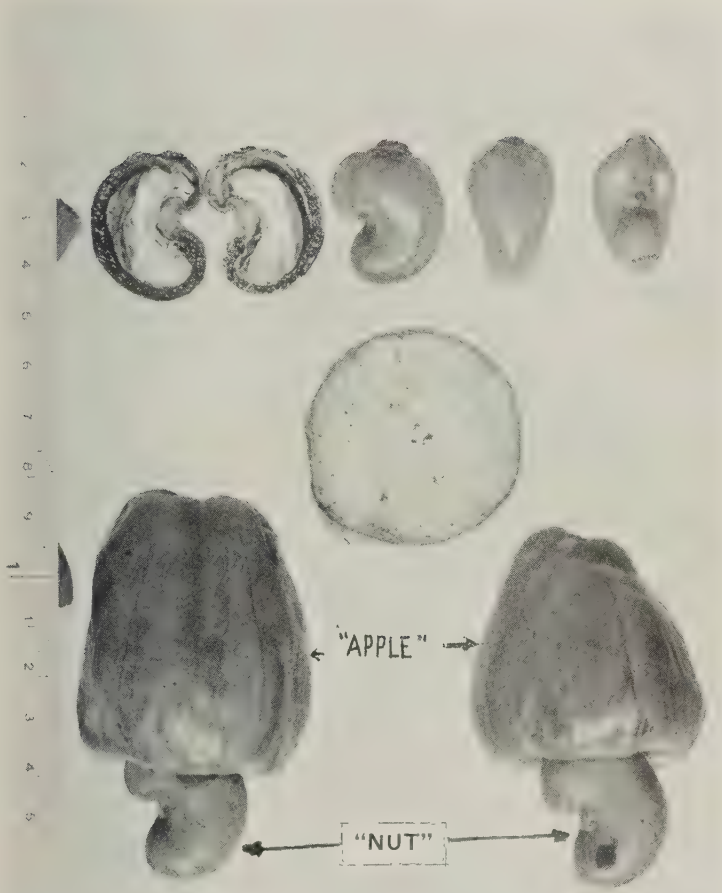

PLATE 6.

PLATE 7.

PEANUT CULTURE [1]

By Juan M. Ejercito and Julio Jamias [2]

Of the Plant Investigation Division
Bureau of Plant Industry

THREE PLATES

The peanut (*Arachis hypogaea* Linn.) which is widely known in the peanut-growing countries of the world as mani, groundnut, goober pea, etc. is now cultivated widely in the Philippines. It was introduced into this country by the Spaniards by way of Mexico and China.

According to latest statistical reports, the area planted to peanut in the Philippines in 1938 was 6,420 hectares with a production of 3,814,520 kilos of shelled nuts valued at ₱362,260. The production has been undoubtedly increased because many of the sugar lands which could not be planted to sugarcane because of the limitations imposed by the Sugar Limitation Act had been planted to other cash crops like the peanut. The great demand for peanut seed is also a good index that the peanut is gaining more popularity now among prospective peanut growers than in the past decade.

MARKET

Besides the local yearly importation which amounts to ₱785,418, our peanut has open markets in many progressive countries like the United States and its possessions. It leaves our ports free of duty. With proper handling, such as sorting, curing and protective legislation, our peanut industry is bound to attract greater attention and to yield bigger cash returns. The other countries where our peanut can be exported are Hawaii, Guam, and Hongkong. The undeclared Sino-Japanese war and the war in Europe have greatly reduced the world production of peanut so that its market price has consequently gone up.

It is worth remembering, however, that to enable us to supply this demand there is need of producing only quality peanut for export purposes.

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[1] To be reprinted as farmers' circular No. 9 (revised).

[2] Received for publication November 27, 1940.

USES

Peanut as food has many uses. Its main utility is for the industrialists and confectioners. One kilo of peanut is equivalent to $\frac{1}{4}$ kilo of protein and $\frac{1}{2}$ kilo of fat. Its calorific value in terms of one pound whole peanut is 2,700 calories. Foodstuffs like beefsteaks and eggs have calorific values equal to $\frac{1}{3}$ and $\frac{1}{5}$, respectively, that of peanut only.

Peanut meal, a by-product from oil extraction when made into flour, makes a very excellent food for diabetics. The peanut, therefore, is a good substitute for meat and is very good for vegetarians.

Peanut oil is used in packing sardines, for medical emulsion and as a substitute for olive oil.

The properly cured leaves and stems called peanut hay serves as an excellent forage for milk animals.

ADAPTATION AND DISTRIBUTION

Peanut thrives at practically all elevations and under a wide range of soil and climatic conditions in the Philippines. Good-quality peanut is raised in regions where there are distinct dry and wet seasons. Usually the peanut-producing provinces are in these regions and their adaptation to peanut cultivation is shown by their production as compiled hereunder by the Division of Statistics of the Department of Agriculture and Commerce for the year 1938:

Provinces	Area planted	Production	Yield per hectare (shelled)	Average price per 100 kilos	Total value
	Hectares	*Kilos*	*Kilos*	*Pesos*	*Pesos*
Lanao	593	353,200	596	6.34	22,410
Leyte	579	340,160	587	10.70	36,400
Pangasinan	541	338,230	625	11.21	37,910
Cagayan	367	247,360	674	8.35	20,660
La Union	352	228,800	650	8.50	19,450
Nueva Ecija	303	177,970	587	10.42	18,840
Cebu	258	116,100	450	8.50	9,870
Isabela	225	189,000	840	7.80	14,740
Ilocos Norte	192	127,380	663	8.80	11,200
Batangas	172	118,680	690	13.40	15,900

Comparing the three leading peanut-growing provinces of the Philippines, it is evident that climate and soils are the two principal factors that affect the yield of peanuts. It is easily seen that Lanao leads in production as well as in hectarage,

and Leyte ranks second, but Pangasinan beats the two provinces in yield per hectare. This difference may be explained by the fact that excessive rainfall and very rich soil enhance more vegetative growth but less yield. Too much moisture also affects the quality of peanut. Of the three leading peanut-growing provinces, Pangasinan has distinct dry and wet seasons. Batangas has so far the highest average price per 100 kilos of shelled nuts, ₱13.40. Peanut growers in Batangas take pains in raising quality nuts by proper curing, drying and sorting.

VARIETIES

The Bureau of Plant Industry has introduced a number of promising peanut varieties into this country. Of the recent introductions, the Bukalasa (P. I. No. 13243) from Reduit, South Africa, the Spanish White (P. I. No. 14821), and the Virginia Bunch (P. I. No. 14916), both from the U. S. Department of Agriculture, Washington, D. C., had been found to be well adapted to local conditions. The other varieties that are worthy of cultivation are the Spanish (P. I. No. 7976), San Mateo (P. I. No. 7974), San Jose (P. I. No. 7980), Virginia Jumbo (P. I. No. 11449), Kinorales (P. I. No. 7977), Tennessee Red (P. I. No. 8304), Vigan Lupog (P. I. No. 7978), Cagayan (P. I. No. 14332) and Macapno (P. I. No. 14320).

Of the varieties recommended for confectionery purposes, the Virginia Jumbo, Virginia Bunch, and Tai-tau should be raised. For oil production and other industrial purposes the Spanish White should be preferred and for home consumption, the San Jose No. 1 and the Bukalasa. The Spanish White is common throughout the Philippines while the San Jose No. 1 is very popular in Nueva Ecija.

CLIMATIC AND SOIL REQUIREMENTS

For commercial planting, peanut should be grown at from sea level to not more than 500 feet elevation. It prefers a warm climate and moderate rainfall throughout its period of growth. Other conditions being equal, higher yields are obtained in places where the rainfall ranges from 42 to 54 inches annually.

Peanut will grow on any type of soil, but it grows well and produces more on fine sandy soil with a moderate supply of organic matter, phosphorus and potash. A liberal supply of lime is highly desirable for the proper development of the pods. Sandy loam soil is also good for this crop. Hard, stiff clay soil

is not suitable because the pegs bearing the would-be-pods can hardly penetrate the soil, thus hindering the proper development of the pods.

PROPAGATION

Peanut is generally propagated by seeds. The vegetative method of propagation—stem cutting—is impracticable on a commercial scale. Good seeds should be selected for planting. The practice of planting shelled nuts on large plantations can be dispensed with by sowing direct unshelled seeds. This will save extra expense in shelling. In order that a high percentage of germination may be attained, the pods should be soaked in fresh water for five hours. To insure uniform soaking, weights should be placed over the sack.

Preparation of the field.—It is essential that the soil should be in good tilth before planting. The ground should be tilled at least 15 centimeters deep at the first plowing. Two to three plowings, each followed by a harrowing made at 10 to 15 days' interval, are sufficient to put the soil in good tilth. In the course of these operations, all stubble, weeds, and obstruction of all kinds should be removed.

Time to plant.—The peanut is planted practically at the same time as corn. Two crops are easily raised twice a year, one during the rainy season and the other during the dry. The rainy season culture is generally started in May or early June and harvested in August or September. The dry season culture starts in October or early November, and is harvested in January or February. Plantings made later than June generally catch too much rain, and no amount of cultivation will suffice as the soil is always wet. Consequently the field becomes very weedy. In late dry season plantings the crop suffers from drought and its proper development is arrested due to lack of sufficient moisture.

Seedage per hectare.—It requires about 30 kilograms of shelled seeds of the Spanish variety and other similarly sized varieties to plant a hectare. With the big seeded types, like the Virginia Jumbo and the Tai-tau, about 26 kilograms are sufficient because they are planted farther apart than the small seeded types. Peanut of this type has some peculiarities in that it will not grow if planted immediately after harvest. It needs a rest period of some 5 or 6 months.

Distance of planting.—The small seeded type is generally planted in hills distanced 35 centimeters in rows 65 centimeters

apart. The creeping or big seeded type is usually spaced 50 to 80 centimeters. At least three seeds are planted to every hill; one pod when the unshelled seeds are used. They are covered with fine soil at a depth of 3 to 6 centimeters. During the dry season when the planting is delayed and there is no sufficient moisture in the soil, it is advisable to soak the seeds in water overnight before planting to hasten germination. Only well seasoned seeds from the preceding crop should be planted.

CULTIVATION AND CARE OF THE CROPS

Start to cultivate when the weather is fair and as soon as the plants have two to three leaves. It is always advisable to practice flat cultivation in order to induce uniform maturity of the pods and to discourage the second set of fructification. This is done by passing a five-toothed cultivator as often as necessity demands until the first appearance of flowers. This will keep the field practically free from weeds. The plants at this stage should be growing fast and should cover the spaces between, thus minimizing the further growth of weeds. The soil must not be worked on because the peanuts by now are in the pegging stage and any disturbance on the plant will result in the production of more pops than perfect pods.

Special cultural practices.—In the United States, after final cultivation, a light roller is run over the plants to flatten the stems upon the ground and to enable the pegs bearing the would-be-pods to reach the soil. This practice is followed only with the runner varieties. This tends to cause the greatest number of pods to mature almost at the same time. It is not followed with the erect type, as the plants may be seriously damaged.

Crop rotation.—The peanut should not be grown on the same piece of land oftener than once in two or three years. It should be rotated with legumes such as cowpeas, and mungo; corn, tobacco, cotton, and other cover crops. Rotation will partly check the occurrence of pests and diseases, will provide a mellow soil, and prevent the exhaustion of one kind of plant food element in the soil and avoid mixture due to leftovers.

FERTILIZERS

Unlike other field crops, peanut needs soil of medium fertility. Very rich soil will produce rank growth and less pods. Jamias(3) found that a top dressing of 750 kilos of single super-

phosphate per hectare with peanut on the San Manuel fine sand of Pangasinan showed an increased yield of 11.6 per cent. Carver(1), a world famous peanut wizard, stated that peanut adjusts itself to many kinds of fertilization, makes a splendid yield when given the same treatment as corn, cowpeas and cotton. In one of his fertilizer works on peanut grown in sandy soil he used as top dressing 112 kilos of acid phosphate, 56 kilos kainit and 224 kilos lime per hectare and a heavy application of 18 tons of thoroughly mixed compost. Lime improves the quality of peanut; the pods are better filled and the shells are whiter.

Silayan(6) found that wood ash when applied at the rate of 7,200 kilos per hectare increased the oil content of the different varieties tested, by an average of 3.5 per cent. He also found that a mixture of ash and stable manure in the proportion of 1 to 5 or equivalent to 9,315 kilos per hectare gave an increase of 3.46 per cent of oil.

Fertilizer placements.—Unlike other field crops, peanuts do not readily respond to fertilizer placements. Collins(2) did not find significant increases when he tried the following variables: (*a*) 2.5 inches on both sides of the plant, (*b*) 2.0 inches below seed level, and (*c*) 1.75 inches band, 2 inches below the seed level and fertilizer mixed with soil mostly under seed.

HARVESTING

The proper time to harvest is just as important as any other field operation in the growing of peanut, because some varieties, like the Spanish, germinate readily or rot if allowed to overmature in the field. Defoliation follows, and part of the value of the forage will be lost. The signs of maturity are as follows:

1. General yellowing of the foliage including those nearest the apical buds.
2. Darkening of the interior wall inside the shell of the pods.
3. The usual maturing period of from 105 to 125 days of most of the small seeded type, and 165 to 185 days of most of the big seeded type.

Harvesting should be done preferably during good weather and when the soil is not too wet. One great objection to the rainy season culture is the frequent coincidence of the harvesting time with the rainy days. While waiting for more suitable weather, the pods become overmature and many rot or germinate. The Spanish variety possesses this characteristic. The drying also of the newly harvested pods is difficult.

CURING

Curing is not commonly done in the Philippines. The usual practice is to pick the pods immediately after harvest and dry them in the sun. This results in the production of many shriveled kernels. In the method of curing described hereunder the nuts are given enough time to draw nourishment further from the vines, so that the resulting kernels are not shriveled after curing. Moreover, the nuts as well as the hay are cured to about the proper color.

Method.—The curing poles are made either of bamboo or wood measuring about 2.5 meters long and 7 to 10 centimeters in diameter. Two crosspieces, 40 to 55 centimeters long, are nailed to the pole at right angles to each other 30 centimeters high from the ground. These crosspieces will hold the plants and prevent them from touching the ground. The pointed butt of the pole is sunk at least 30 centimeters deep in the ground.

After the plants are harvested with the pods, they are shaken to remove the adhering soil particles, and spread on the ground for exposure to the sun to slightly wilt the vines for a few hours. The wilted plants are hung on the crosspieces with the pods nearest to the pole while the leaves are allowed to hang freely. The vines are continuously piled around the pole, pressing them down occasionally. The stacks should not be more than 5 feet high in order to provide moderate ventilation and avoid souring. When completed, the stack will have its center a little raised. The top is capped with some weeds or straw as protection from rain. Normal curing lasts from 3 to 4 weeks on sunny days.

Well cured and sorted peanuts of good quality are sold at higher prices than the uncured and unsorted. Proper curing eliminates the brown spots on the nuts that occur during storage or while in transit.

PICKING AND SHELLING

After curing, the pods are preferably picked during bright and hot weather when the vines are brittle and picking is easier. During cold weather the vines are rather tough and picking is difficult. Separate the marketable pods from the unmarketable while picking. Properly picked pods should be free from stems, dried leaves, and other foreign materials.

The native and usual way of shelling is to press the pods between the fingers, taking care of course not to press so hard as to split the kernels. Plenty of split kernels lower the quality

of the product in the market. The hand method of shelling is quite slow, laborious, and expensive when the crop is handled on a big scale. The work may be facilitated and the expenses minimized by the use of a shelling machine.

YIELD

Like any other crop, the yield of peanut varies with the variety, season, type of soil, culture, diseases, pests, etc. The Bureau of Plant Industry found that in Lamao, San Jose No. 3 yielded 12.69 cavans of shelled nuts; Spanish, 12.55 cavans; and Tennessee Red, 11.99 cavans. In Los Baños, the College of Agriculture reported 26.4 cavans of pod per hectare; 19.4 cavans for the Spanish Red; 25 cavans for Vigan Lupog; and 23.1 cavans for Kinorales.

SEED STORAGE

Storing seeds for planting is not as difficult as storing seeds of other farm crops because the morphological nature of the peanut seed gives it a natural protection. However, careless handling often results in low percentage of germination and shortage of seeds. The following rules should be observed in storing peanut seeds for planting:

1. Only large-sized and well-filled pods should be stored.
1. The selected pods should be dried thoroughly in the sun before storage in tight containers.
3. The seeds should be stored in rice bins or bodegas and exposed to sunshine once in a while when handled on a big scale.
4. The stored peanuts should be kept away from rodents.

PESTS AND DISEASES

Peanuts have either very few insect enemies or none at all. Only rats and crows that dig and eat the pods may be mentioned.

Leaf spots.—This is a common disease of peanut which appears when the plants are about to mature. In extreme cases, it defoliates the plants.

Sclerotium rolfsii Sacc.—This was found destructive not only to peanut but also to several vegetable and field crops. Reyes(4) reported its symptoms as follows:

(*a*) First, the upper portion of the twigs wilts as if it is affected by drought. This is followed by the drooping of the foliage and the losing of the normal green color. The fungus attacks the stem and crown and roots near the surface of the ground level.

(*b*) Branches, leaves and young shoots near the surface of the ground are attacked and copious white coarse dense mat or radiating mycelium may be seen in the soil immediately surrounding the infected parts. In a short time small white spherical bodies form copiously on the surface of the affected tissues. The sclerotial bodies later become buff or brown-colored.

Brown spots.—This disease disfigures the surface of the nuts as manifested when the infected nuts are boiled in odorless cooking oil. While this malady is not well known in the Philippines yet it affects the quality of the local nuts exported to the United States. Serrano(5) of the Bureau of Science, in an unpublished paper, found that dry-season grown nuts, if properly cured, do not show appreciable brown spots while those produced during the rainy season show plenty of brown spots. Further studies are being conducted along this line.

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ILLUSTRATIONS

PLATE 1

How peanut plants should be stacked on poles. Note the pods which are set nearer to the pole and are higher than the leaves to insure drainage when it rains.

PLATE 2

Peanut stacks when completed.

PLATE 3

Peanut culture at Maligaya Rice Experiment Station. Early preparation of the land, right time of cultivation and use of viable seeds rendered this plantation presentable and assure a bountiful harvest. Unshelled nuts were used as seeds.

PLATE 1.

PLATE 2.

PLATE 3.

SUPPLEMENT

(The authors considered timely the inclusion of the attached letters and circulars from the Bureau of Commerce as they are self-explanatory and place the Philippine peanut industry in its true light to the end that a better understanding may be had between the planters and the exporters)

MALIGAYA RICE EXPERIMENT STATION
MUÑOZ, N. ECIJA, *December 12, 1939*

The DIRECTOR
Bureau of Commerce
Manila, Philippines
(Thru the Superintendent of Station)

SIR:

Will you kindly give me some account of the news I overheard from some peanut exporters why Philippine peanuts exported to America oftentimes do not command good price and sometimes are entirely rejected? Also have you ever come across some peanut exporters that export only cured peanuts? Which peanuts command better price—those harvested during dry season or those during wet season? Do American importers offer any price on red cuticled peanuts? What about mixed kernels? What is the regular price per 100 lbs. of shelled peanuts in America?

Very truly yours,

(Sgd.) JULIO JAMIAS
Assistant Agronomist

COMMONWEALTH OF THE PHILIPPINES
DEPARTMENT OF AGRICULTURE AND COMMERCE
BUREAU OF COMMERCE
MANILA

December 19, 1939

Mr. JULIO JAMIAS, Assistant Agronomist
Bureau of Plant Industry
Maligaya Rice Experiment Station
Muñoz, Nueva Ecija

SIR:

In reply to your letter of the 12th instant, we are pleased in giving the following information regarding peanut.

1. Certain lots exported to the United States were rejected or penalized because the nuts were either below specification, mouldy or damaged.
2. We know of no exporter shipping cured peanut.
3. The period of harvesting does not influence the price. Provided the nuts are well matured and properly dried, they command good price in the market.
4. Red cuticled peanut of suitable quality and in commercial quantities may be exported to the United States. Lots of 100 or more bags may be offered to importers.
5. Mixed kernels are exportable but they do not command so good a price as uniform kernels do.
6. The latest price we know of paid in the United States for Philippine peanut was ₱12 per 100 pounds c. i. f.

Very respectfully,
For the Director of Commerce:

(Sgd.) PABLO F. SULIT
Chief, Commodity Section

COMMONWEALTH OF THE PHILIPPINES
DEPARTMENT OF AGRICULTURE AND COMMERCE
BUREAU OF COMMERCE
MANILA

August 4, 1939

COMMERCE CIRCULAR
No. 131

SUBJECT: Rules Governing the Grading and Inspection of Shelled Peanut For Export.

Pursuant to the provisions of section 3 (*a*) of Act No. 2728, the following rules on the grading and inspection of shelled peanut for export are hereby prescribed for the guidance of officials and employees of this Bureau assigned to perform inspection work and all parties interested:

1. *Issuance of certificate of inspection.*—Upon request of the exporter, certificates of inspection shall be issued for shipments of shelled peanut coming up to the standard classifications set forth in this Commerce Circular.

2. *Definition of terms.*—As used in this Circular and for the purpose therefor, the following terms shall mean:

(*a*) *Shrivel* shall be whole kernel, the whole or greater portion of which is wrinkled.

(*b*) *Split* shall be whole kernel the endosperm of which is partially or entirely parted.

(*c*) *Damaged kernel* shall be kernel that shows mold, sourness or rancidity or which is wholly or partly damaged.

(*d*) *Foreign matters* shall be particles of clay, stone, or dirt, and the like.

(*e*) *Percentages* shall be determined by weight.

3. *Procedure of inspection.*—Inspection of shelled peanut shall be made as follows:

(*a*) Shipments of shelled peanut for which request for inspection has been made shall be inspected by duly appointed inspectors of the Bureau of Commerce.

(*b*) Request for inspection shall be made on forms provided by the Bureau of Commerce and submitted at least five days before shipment.

(*c*) The inspection of every lot or shipment shall be made as follows:

(1) The sample shall be taken from at least 10 per cent of the entire shipment at the discretion of the Inspector.

(2) All of these samples shall be mixed together and two lots of 1 kilogram each shall be taken from the mixture which would then represent the entire shipment, a portion of one lot to be kept by the Bureau of Commerce and the other lot, upon the request of either the importer or the exporter of both, to be sent to the Bureau of Science for analysis of moisture content.

(3) The sample shall be the basis of the test in accordance with the specifications enumerated below.

4. *Classification and grading*—Classification and grading of shelled peanut for export shall be done as follows.

(*a*) There shall be three general classes of Philippine shelled peanut for export:

Class I.—Big-kerneled Type: Kernels numbering less than 45 per 25 grams (0.88 oz.)

Class II.—Medium-kerneled Type: Kernels numbering 45 to 54 per 25 grams (0.88 oz.)

Class III.—Small-kerneled Type: Kernels numbering 55 or more per 25 grams (0.88 oz.).

(*b*) All of the above classes of shelled peanut shall be divided into grades, the designations and requirements of which shall be specified in accordance with the following tables:

Grade	Shrivels not more than %	Splits not more than %	Damaged kernels not more than %	Foreign matters not more than %
P. I. No. 1	30	1.5	2	.2
P. I. No. 2	40	2.00	3	.4
P. I. No. 3	60	2.5	4	.6

(*c*) *Sample grade.*—Quality of shelled peanut agreed upon between the buyer and the seller which is not included in the preceding table may be inspected upon request, in which case the shipments shall be sampled by the Bureau of Commerce inspectors and specimens thereof kept in sealed containers in the Bureau of Commerce for at last 3 months after date of shipment.

(*d*) *Moisture content.*—An analysis as to the percentage of moisture content may be made by the Bureau of Science at the request of either the importer or exporter or both, and any expense incurred thereby shall be paid for by the party requesting the analysis.

(*e*) Color, size, condition and general appearance.—

(1) *P. I. No. 1* shall be composed of matured, well-dried peanut, either big-sized or medium-sized or mixed, and either light-brown or dark-brown or red or mixed, free from all defects that may impair its value other than those allowed in the table.

(2) *P. I. No. 2* shall be composed of matured, well-dried peanut, either medium-sized or small-sized or mixed, either light-brown or dark-brown or red or mixed, free from all defects that may impair its value other than those allowed in the table.

(3) *P. I. No. 3* shall be composed of matured, well-dried peanut, small-sized, and either light-brown or dark-brown or red or mixed, free from all defects that may impair its value other than those allowed in the table.

5. *Certificates of quality.*—A certificate of quality shall be issued for every shipment of shelled peanut inspected if the quality of such shelled peanut conforms to the above specifications. The certificate of quality shall be accepted as final except on manifest error and upon a written statement of the exporter concerned filed with the Director of Commerce

within 5 days after the date of issuance of the certificate in question. The said Director shall make decision thereon which shall be appealable to the Secretary of Agriculture and Commerce within 15 days from the date of the exporter's receipt of said decision.

6. *Fees.*—For the inspection of shelled peanut in connection with the classification and grading provided in rule 4 hereof, there shall be collected a fee of one centavo (₱0.01) per sack of 100 pounds. In case of small shipments not exceeding 200 bags a minimum service charge of two pesos (₱2.00) shall be collected. Such fees shall be paid by the applicant to the Bureau of Commerce and upon the issuance of the certificate of inspection.

7. *Peanut of the domestic trade.*—Shelled peanut intended for the domestic trade may be officially graded and inspected at the option of the contracting parties under the following:

The terms as defined in rule 2 of this Circular shall also apply to shelled peanut for the local trade. The same procedure or inspection set forth in rule 3 of this Circular shall be followed, and the same general classes and grades of shelled peanut enumerated in rule 4 shall be binding on shelled peanut intended for local trade. The fees shall be those fixed in rule 6.

6. *Effectivity.*—If and when approved by the Honorable Secretary of Agriculture and Commerce, this Commerce Circular shall take effect as of August 1, 1939.

(Sgd.) C. BALMACEDA
Director of Commerce

APPROVED:

(Sgd.) BENIGNO S. AQUINO
Secretary of Agriculture and Commerce

ERRATA

INSECT AND OTHER PESTS OF CORN, by Faustino Q. Otanes and Leopoldo T. Karganilla, volume 11, No. 4:

Page 430, plate 8, figure 3—Read "Larva of a beetle," "cadelle," *Tenebriodes mauritanicus* L. instead of that of *Sitotroga.* This beetle is also a pest of stored grains.

Page 426, paragraph 6, line 1—Cancel plate 8, figure 3.

BUREAU OF PLANT INDUSTRY

AGRICULTURAL EXPERIMENT STATIONS

1. Central Experiment Station, Manila
2. Lamao Experiment Station, Limay, Bataan
3. Maligaya Rice Experiment Station, Muñoz, Nueva Ecija
4. Lipa Citrus Experiment Station, Lipa, Batangas
5. Baguio Experiment Station, Baguio
6. Ilagan Tobacco Experiment Station, Ilagan, Isabela
7. Maridagao Rubber Station, Pikit, Cotabato
8. Los Baños Economic Garden, Los Baños, Laguna
9. Guinobatan Abacá Experiment Station, Guinobatan, Albay
10. Mindanao Experiment Station, Aroman, Carmen, Cotabato
11. Granja Sugarcane Experiment Station, La Carlota, Occidental Negros (under lease)

SUBSTATIONS AND SEED FARMS

1. Davao Seed Farm, Davao Penal Colony, Davao
2. Kidapawan Wrapper Tobacco Substation, Kidapawan, Cotabato
3. Halcon Rubber Substation, Baco, Mindoro (under lease)
4. Gandara Seed Farm, Gandara, Samar
5. Abuyog Abacá Substation, Abuyog, Leyte

RESERVATIONS

1. Gingoog Lanzon Reservation, Gingoog, Oriental Misamis
2 Abacá Disease Station, Kapatalan, Siniloan, Laguna
3. Quisolon Reservation, Quisolon, Bukidnon
4. Bansalan Reservation, Davao

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